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The Mannesmann Tube Co. proposes to establish a plant for the manufacture of its tubes in the United States within the next few months; but has not yet decided upon a location. The company has exhibits of its tubes at the Columbian Exposition in the Mining Building and also in the Transportation Building. The location in each case is near the southern entrance. The exhibits are in charge of Robert Mannesmann, a brother of the inventor of the tube-making process, which, as most of our readers will remember, consists in rolling the tube from a solid round bar.

The electrical treatment of Croton water by the Woolf process, described in our issue of July 27, we are informed by Dr. Cyrus Edson, Health Commissioner of New York city, is designed for use only from about the middle of June to the middle of September, to remedy the bad taste, odor and appearance common to stored water at that time. Dr. Edson states that he believes the Croton is one of the best water supplies of the world, taking into consideration both its purity and great amount, and for the present needs no purification except during the summer months.

A trolley-driven boat system is proposed for the Grand Canyon of the Colorado. According to a California press item a party is now investigating the feasibility of driving small boats by this system through the Black Canyon and other scenic points in connection with Santa Fe railway interests. The power could be generated by water-power. The main feature of the scheme, however, is said to be to use the surplus power for pumping water to a height sufficient to irrigate vast tracks of rich mesa land, which only need water to make them exceedingly well adapted for the cultivation of early fruit.

A railway line from the Indian Ocean to Lake Victoria Nyanza, in Africa, has been surveyed by order of the British Government. By the most direct route the line would be about 657 miles long, and the estimated cost is $11,200,000, or an average of $17,245 per mile. The gage would be 3½ ft., with 50-lb. steel rails and steel ties. No tunnels are encountered, nor are there any important bridges. For this heavy outlay the estimated earning capacity of the road is very small to start with; and with the low estimate of $316,000 per annum for working expenses a deficit of $300,000 per year is looked for for some years to come. This railway would doubtless materially assist in developing the lake regions, now under British control, but some time will elapse before the track is laid.

The most serious railway accident of the week was a derailment on the Ohio Valley Ry., about two miles south of Morganfield, Ky., July 25. A southbound freight train ran into some cattle. The engine was thrown to the left of the track, the tender being driven in front of the engine, and six freight cars were piled one upon the other. The whole caught fire and the engineer, fireman and a brakeman, as well as the cars, were burned.——A head collision occurred on the Lake Erie & Western road about four miles north of Indianapolis, Ind., July 28. A southbound Pennsylvania passenger train was 45 minutes late and ran into a freight train of the same company. The collision was caused by the failure of the crew of the freight train to carefully examine the registry books at the Belt, they supposing that the passenger train had passed. Eight persons were injured.

A bridge at Bessemer Junction, Colo., gave way under a Union Pacific coal train, July 26, and the engineer was killed and the fireman fatally injured. The bridge had been weakened by a storm.——A highway bridge near Muncie, Ind., gave way July 24 under a traction steam thrashing machine, and one person was injured.——A highway bridge over Pine Creek, near Etna, Pa., gave way, July 26, under a thrashing machine, and one person was injured.——The 500-ft. trestle on the Philadelphia, Reading & New England road, between Twin Lakes and Chapinville, Conn., was partially burned July 24.

A boiler exploded at Salem, Ky., July 26, killing two persons and injuring one.——A boiler in Kenny & Newgard's flouring mill at Hawarden, Ia., exploded July 24, injuring two persons.——Two boilers of the Belleville Distillery Co. exploded at Belleville, Ill., July 26, causing a loss of $20,000.——The boiler of the only locomotive on the Martha's Vineyard R. R. exploded at College City, Mass., July 31.

A lock-canal, through the San Joaquin Valley, to cost $10,000,000, is projected by California capitalists. As outlined, the canal would be 175 miles long, passing from Suisun Bay to Tulare Lake. By means of the locks required it is proposed to distribute water through the lower country for irrigation, water power and electric lights. The San Joaquin and Kern rivers and the Tulare, Buena Vista and Kern lakes would be utilized. The scheme is far-reaching, but it is expected that those controlling the present carrying trade will have considerable interest in delaying its construction.

The Corinth ship canal, connecting the Gulf of Lepanto with the Aegean Sea, was formally opened on July 29, though some little time will yet elapse before this new route will be free to commerce. The canal was commenced in 1882, but work was delayed by financial troubles of various kinds. The details of this canal have been frequently described in previous issues.

The clearing away of the ruins of the burned cold storage building at the Columbian Exposition has furnished an interesting object lesson in the good use which was made of one of the portable cranes built by the Industrial Works, of Bay City, Mich. Four cranes from this establishment were in continuous use for several months installing the exhibits; and the morning after the fire one of these was set to work clearing up the ruins. The advantage in doing work in this manner compared with the old system of hand work, aided only by block and tackle, and occasionally a tired horse to pull on a rope, has been fully shown. When the crane hauls away on a timber or other heavy piece, there is no jerking or shouting or stopping to take breath. It is simply a steady pull, and the capacity of the machine is such that the piece has to come, unless it is immovably held. Then the crane hoists it up and deposits it on a car or wagon. By laying down a temporary track the machine can be run wherever desired, as the work progresses, and the time-destroying labor of rigging up hand derricks is done away with.

A decision has been filed in Milwaukee by Judge Seamans, of the U. S. Circuit Court for the District of Wisconsin, in the suit brought by the Edison General Electric Co. against the Electric Mfg. Co., of Oconto, Wis., upon the Edison incandescent lamp patent. The suit was brought against the Oconto company for infringement of the Edison patent by manufacturing and selling incandescent electric lamps, and the decision grants an injunction against the Oconto company, restraining it from any further manufacture and sale of such lamps. The decision is in line with the decisions of the Second Circuit, and of Judge Colt, of the Massachusetts Circuit. The validity of the Edison patent was attacked by the defendant through the claimed priority of the Goebel incandescent lamp.

The first 13-in. navy gun, and the largest rifled gun yet made for the United States, is soon to be tested at Indian Head. This gun weighs 135,500 lbs., or 60.5 tons, is 40 ft. long and 49 in. in maximum diameter, and will discharge an 1,100-lb. projectile with 550 lbs. of powder. The proposed muzzle velocity is 2,100 ft.-sec., developing a muzzle energy of 33,627 ft.-tons. This energy would send the projectile through 23.4 in. of steel at a distance of 1,500 yds. Four of these guns are to be used on each of the battleships "Indiana," "Massachusetts" and "Oregon." But for the "Iowa," a still heavier and later battleship, 12-in. guns of 45.2 tons weight and 36.8 ft. long are to be substituted for the 13-in., as it is now believed that it is not advisable to depend upon guns wholly handled by machinery, which might be disabled at a critical moment. The 12-in. gun, with an 850-lb. projectile and 425 lbs. of powder, would, with a muzzle velocity of 2,100 ft.-sec., develop a muzzle energy of 26,000 ft.-tons and penetrate 21 ins. of steel at 1,500 yds.

Premiums of $1,000, $500 and $250 are offered by the city of Evansville, Ind., for the three best plans submitted for the new water-works for that city with a capacity of 20,000,000 gallons daily; plans to be sent in prior to Oct. 1 next. With the plans engineers are also to submit an estimate of cost and separate sealed proposals stating the price and terms upon which they will consent to act as supervising or consulting engineers. The plans are to embrace the most improved system of filtration and distribution. All surveying and sounding will be done by the city under the supervision of the respective competing engineers. The engineer submitting the best plan is to be appointed consulting engineer, provided the terms submitted by him are satisfactory to the city.

The highest railway bridge in Germany is now under construction on the line of the Solingen-Remscheid railway, a line 7 miles long. This viaduct will be double-track, 1,640 ft. long and 351 ft. high above the water surface, with an elliptical arch of 558 ft. span in the center. The total of iron in the structure will be 4,100 tons, and the estimated cost, including 13,080 cu. yds. of masonry, is $625,000. The members will be put in place by a cable hoisting system operated by electricity. It will not be finished for two years yet.

The submarine telegraph system of the world, says "Herepath's Journal," comprises 1,168 lines, extending over 140,344 nautical miles. Of this total, various governments own 14,480 miles of cable and 21,560 miles of wire. Private companies own 288 cables and 127,632 miles of wire.

The Mexican government, in view of decreased revenue from imports, has reduced government salaries from July 1 to Dec. 31, 1893. For this period the salaries of all government employees suffer the following discounts: Those up to $602 per annum, 5%; those between $602 and $1,000, 7½%; those above $1,000, 10%. After Jan. 1, 1894, the amounts due through such deductions are to be paid in 3% bonds of the Interior Consolidated Debt.

A subway system for electric wires and for water and gas pipes has been devised by Mr. Solon G. Howe, of Detroit, which seems to be well considered throughout. For crowded streets he proposes a subway 8 ft. high and 6 ft. wide in the clear, built of brick or with U-shaped steel walls and roof on a concrete base. In these the wires would be carried in troughs on insulated brackets, on each side, leaving a space for water and gas beneath and a footway between. On side streets he proposes to carry the wires in a duct of vitrified tubing, with a bituminous joint, laid in concrete in a wooden box. This box is surrounded with broken stone and underlaid with a tile drain connecting with the sewers. The manhole or junction box is wholly of cast iron, or of brick with a cast iron cover. Space forbids going into full detail; but the following estimates of cost furnished by Mr. Howe are interesting: The 6 × 8 ft. subway of brick and steel, with water and gas mains, air duct, and shelves for wires and cables laid in Detroit soil conditions, will cost from $38 to $40 per lineal foot. The U-shaped steel tunnel would cost from $25 to $28 per foot. The 4 × 4 ft. brick manholes 6 ft. deep, with all appliances, will cost $60 each; and the steel manhole $45. The cast iron junction boxes, complete, will cost about $30 each. The cost per lineal foot for the 2-in. conduit pipes for smaller streets would range about as follows: One 2-in. duct, 30 cts.; six 2-in. duct conduit, 20 cts.; twelve 2-in. duct conduit, 17 cts., with intermedite number of ducts about in proportion. The round cost of the 6 × 8-ft. subway system is placed at $100,000 per mile. Mr. Howe does not propose to patent his system but will provide complete working plans for from $500 to $1,500, according to intricacy of plant.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 61.—With inset.)

Chemical Precipitation at the World's Columbian Exposition.

Of the many object lessons at the World's Columbian Exposition, one of the greatest, from a sanitary point of view, is the sewage purification plant. At this plant all the sewage from the Exposition buildings is purified by means of chemical precipitation on the continuous plan, the plant being modeled after that at Dortmund, Germany, designed by Mr. Carl Kinebuhler. The Dortmund plant, with several others using vertical precipitating tanks, was described in Engineering News of Feb. 7, 1891. The Chicago plant is located in the southeast corner of the grounds, near the stock exhibit and close by the car and power-house.

The whole sewerage and drainage system for the Exposition is interesting and instructive, and was described in detail in our last issue.

A general plan of the purification works is shown by Fig. 1, on the inset sheet, and a combined elevation and section of the tanks by Fig. 2. From these two figures it will be seen that the plant consists of an elevated receiving and distributing tank, four chemical mixers, four precipitating tanks, two boilers, a 50-HP. engine, two air compressors, three sludge receivers, two sludge filter presses, two pumps and other accessories, all inclosed in one building. The building is 100 × 125 ft.

The main outlet sewer terminates in a vertical stand-pipe 3 ft. in diameter and 49 ft. ½ in. in height, which extends nearly to the top of the receiving and distributing tank, shown in section and detail by Fig. 3. This stand-pipe is made of ¼-in. tank steel, riveted in 5-ft. lengths with ½-in. rivets having 1½-in. pitch, the seams lapping 1½ ins. The pipe terminates in a bell mouth, is riveted to the top of the stand-pipe, and the top of the mouth is secured as shown by detail B, Fig. 3.

The receiving tank is 16 ft. in diameter and 10 ft. high, or 8½ ft. high to the top of the grating, which gives a capacity to the latter point of 12,750 gallons. Like the stand-pipe it is of ¼-in. tank steel, with 1½-in. lap at the joints and ½-in. rivets with 1½-in. pitch.

The sewage discharges from the bell mouth of the stand-pipe onto a grate screen 18 ins. below the top of the tank. This screen is in eight sections, and is made of ⅜ × 1½-in. bars on edge, spaced 1 in. c. to c., all as shown in the partial plan of the grating and by details, A and B, and the details of the long and short grate bars, Fig. 3.

The sewage passes down through the grate screens and from the tank through any or all of the four outlets, E, E, shown on the section of the tank, and also in detail, in Fig. 3. Each of the outlet pipes is 14 ins. in diameter and is controlled by a gate.

Sulphate of alumina or copperas is admitted to the sewage as it flows in the outlet pipe from the distributing tank, as shown in Fig. 2. The chemical is thoroughly mixed with the sewage by the machine mixers located in the special in the outlet pipe, and shown in detail by Fig. 4, after which lime is admitted to the outlet pipe and a further mixing of the sewage and chemicals secured by means of the mixer, shown in the section, Fig. 2, and also in detail by Fig. 5. The outlet pipe terminates at the cone mixer in a quarter bend of ¼-in. wrought iron bolted to the pipe by means of a wrought flange with an 18½-in. bolt circle having 16 ¾-in. bolt holes. The cone mixer is suspended in the central cylinder of the precipitation tanks by hangers from I-beams, as is fully shown by Fig. 5. This mixer discharges the sewage over its top edge, the sewage then passing down the central cylinder to be distributed by horizontal arms throughout the lower part of the tank, after which it rises to the top of the large tank and passes out in a clarified state, the solid matter meanwhile having precipitated to the bottom of the tank from which it can be drawn at any time to the sludge receivers and filter presses.

The central cylinder is 6 ft. in diameter and 32 ft. high, made of 3-16 × 60-in. plates. From its bottom the sewage is distributed downward into the conical-shaped bottom of the main precipitation tank by means of eight horizontal radiating arms consisting of inverted V-shaped troughs supported at the outer ends by ½-in. rods from the central cylinder, all as shown in detail by Fig. 6.

After the sewage has passed down through the central cylinder and up through the main part of the tank the effluent is collected at the top of the tank by means of a system of suspended wooden troughs resting in the top of the clarified sewage, all as shown in detail by the various plans, elevations and sections in Fig. 7. The troughs from each pair of tanks lead to a common effluent stand-pipe, 12 ins. in diameter, which conveys the effluent down to the ground where it passes through an outlet pipe to the lake.

The precipitating tanks are 32 ft. in diameter for the first 32 ft. from their top down and then diminish in the form of a cone for 22 ft. to a diameter of 6 ft., making their total height 52 ft. The effluent troughs are 18 ins. below the top of the tanks, leaving the available height of the circular part of the tank 30½ ft. Allowing for waste space the available capacity of the tanks may be taken as 237,000 gallons, of which about 54,000 gallons is afforded by the conical portion of the tank. Of course, it will be understood that the holding capacity of these tanks does not directly indicate their service capacity, the treatment being continuous.

Some of the details of riveting and supporting the conical part of the tanks are shown by Fig. 8. The pile and timber foundations of the tanks are shown in Fig. 2 (most plainly at the right). There are three concentric rows of piling, 30 in each row, 30 ins. c. to c., one beneath and one each side of the outer edge of the tank. Further details and dimensions can be seen on Fig. 2 and in the detail of the junction of the main and conical portion of the tank, in Fig. 8.

The sludge pipes start from the bottom of the precipitation tanks and extend upward and out of the tanks, as shown in Fig. 2. The lower end of each pipe terminates in a bell mouth supported on three legs, as shown in detail by Fig. 9. Each pipe is 6 ins. in diameter and connects with a 6-in. pipe leading to the three sludge tanks or receivers, as shown in Fig. 1.

The detail of the sludge pipe at its passage through the conical bottom of the tank is also shown by Fig. 9.

The three sludge tanks are each 4 ft. in diameter and 8 ft. high in the clear, the ends being curved outward, giving a capacity of about 100 cu. ft., or 750 gallons. A plan, section and details of the tanks are shown by Fig. 10. The sludge passes in at the top and out at the bottom of the tank through the special casting C. Compressed air is admitted through a 2½-in. air pipe entering the top of the tank. A hand hole is provided in the top of the tank and a float and indicator to show when the tank is full; all as shown by Fig. 10.

Upon opening the proper gate in the sludge pipe connecting the precipitation tanks with the sludge tanks the sludge is forced to the sludge tank by the head of sewage above it. When the sludge tank is filled compressed air is turned into it and the sludge is forced into one of the two filter presses, shown in plan by Fig. 1.

Each filter press has 50 cells 36 ins. in diameter and 1½ ins. thick. Each sludge cake weighs about 47 lbs. and each pressful of sludge about 2,350 lbs. The presses proper were made by the Perrin Co., of Chicago, which manufactures filter presses for separating grease at packing-houses, to which these are similar. The iron-work of the presses was made by the G. H. Bushnell Co., of Thompsonville, Conn.

A tramway, shown in Fig. 1, is provided for removing the sludge cakes to the Engle garbage crematory, situated just east of the disposal works. The crematory was described in Engineering News of March 23, 1893.

The two vertical boilers, shown on the plan, Fig. 1, are each of 40 HP. and, like all the boilers on the grounds, are oil fed. The 50-HP. high-speed steam engine was made by the New York Safety Steam Power Co. By means of a belt the engine drives the line shaft, which in turn transmits power to run an elevator, a pulverizer which grinds clay for earth closets, the four chemical mixers, by means of rope transmission, and three centrifugal pumps.

The two air compressors were put in by the Norwalk Iron Works Co., South Norwalk, Conn., and have 8 × 10-in. steam cylinders.

The Worthington pumps, shown on the plan, Fig. 1, are used to pump the local sewage of the disposal building, including the liquid from the presses, to the tanks, and may also be used to empty the tanks.

The heavy flow of sewage, as would be expected, is from 9 a. m. to 6 p. m. Weir measurements of the effluents are taken every hour, and both chemical and bacteriological analyses are being made to determine the results obtained.

The plant was put in operation on April 14, 1893. The average daily flow of sewage since the beginning of May has been as follows:

Month of May	940,000	galls.
" " June	1,630,000	"
First week in July	2,124,000	"
Second " " "	2,219,000	"
Third " " "	2,427,000	"

Experiments are being made with copperas, sulphate of alumina and lime as precipitating agents. The plant is operated with eight-hour shifts, and each shift is instructed what chemicals to use and in what quantities. The morning shift includes an engineer, a fireman and a pressman, with two helpers, and a man to attend to the screens, the chemicals and to take the weir measurements—a total of six men; from the afternoon shift the two laborers are omitted; and on the night shift only an engineer, a fireman and a chemical tender are employed. As each of the four tanks can be operated independently of the others, it is possible to use different kinds and amounts of chemicals with the same sewage. To July 1 the cost of chemicals had been about $8 per 1,000,000 gallons. The results of all the various experiments and detailed figures relating to the operation of the plant will be made available at a later date and will certainly be awaited with great interest by all who are interested in sewage purification.

The cost of the plant, excluding the building, was between $30,000 and $33,000. The plant was built under the direction of Mr. W. S. MacHarg, Engineer of Water Supply, Sewerage and Fire Protection, and is run under the direct supervision of Mr. Allen Hazen, Chemist of the Lawrence Experiment Station of the Massachusetts State Board of Health.

A PROPOSED METHOD OF TESTING STRUCTURAL STEEL.

One of the most interesting papers presented at the recent International Engineering Congress, at the World's Columbian Exposition, was by Mr. Alfred E. Hunt, M. Am. Soc. C. E., describing a proposed new method of testing structural steel. This paper is so especially apropos at the present time when soft and medium steel is rapidly supplanting wrought iron as a structural material, that we give it nearly in full, only condensing and rearranging some parts for more convenient examination, and have also discussed some of the more important features in our editorial columns:

The methods in vogue of testing structural steel, for its quality as well as for its adaptability for the purpose required, in commercial practice at the present time are briefly as follows: (1) Tensile tests, in which the results compared in the crucial examination are the elastic limit and tensile strength per unit of area as well as the percentage of elongation in given lengths and percentage of reduction of area. (2) Bending tests of the metal, both hot and cold and under varying conditions, such as quenching after being raised in temperature to a red heat, etc. (3) Drifting tests, or the enlarging of holes punched or drilled in the metal, by pressure or blows upon a hardened steel drift pin. (4) Drop tests, where specimens under given conditions of support are struck by blows of a falling weight. (5) Chemical analyses, where the amounts of the constituents imparting hardness, as well as those supposed to injure the metal by rendering it either cold or hot-short, are determined.

Some of the disadvantages of these methods of testing structural steel are: that due to the time required and expense occasioned, the tensile and chemical, and, in many instances, the drop tests are made too few in number to discover and check a lack of homogeneity in the metal; also considerably varying results can be obtained by taking specimens from different parts of the ingot or other object to be tested, and in the case of tensile tests by varying the method of testing as to the speed, amount of impact, or the application of strains, or by pulling the specimens out of line.

A further serious disadvantage—not an inherent one, it is true, but still one which, in the writer's opinion, has grown into a grave trouble in the requirements of many specifications and in the general practice of the interpretation of specifications for structural steel of to-day—is the narrowing of the allowable limits of the results of the present system of testing to an extent that is unwise in choosing steel suitable for structural purposes, and which leads to an excessive exclusion of material. This state of affairs is not only unjust to the mills, but unsatisfactory to the shops or constructing concerns. Annoying and expensive delays are often caused by rejection of material which the mill people had confidently reckoned upon shipping at stipulated times in accordance with their promises, on account of its being just outside of the narrow limits of specifications. In many such cases there has been not the least doubt, in the mind of the inspector, the mill management, or the contractor who was to fabricate the material into finished shape, that the rejected steel would have answered equally as well for the purpose for which it had been designed as much of that which had been accepted and which had given test results within the specifications

This state of affairs acts, in the long run, very prejudicially to the interests of the engineer who draws the specification, and sometimes actually to the quality of the metal entering into his structure; for it tends to lower the ideas of the subordinate officials and "practical men" at both the mills and shops as to the utility of specifications and of the necessity of honestly complying with them, as well as to the idea that the engineer, the author of the specifications, does not know what material he actually wants. Added to this, not only does the rejected material cost money, but the losses resulting from delays caused by rejections are, in the long run, figured into the general cost of doing work, and are added to the estimates of costs on which bids for future orders are based. Hence the specifications under which many jobs of work are let, such as some general railroad specifications, often cause considerably higher prices to be charged and paid for, as a result of the narrow limits of the specifications, as determined by previous experience with them. Again, bending, drifting and similar tests of ductility do not give results, in numerical quantities, convenient for reference, comparison and record, or for exact stipulation of requirements in specifications.

The method of testing which the writer proposes consists in punching or otherwise shearing, cutting or drifting pieces of a given thickness of metal, and comparing the "force" required in this work with that required to treat standard pieces in a similar manner. The comparison can be similarly made with the "work" done, or factors of the work exerted therein at different stages of the punching, cutting or drifting operations, with results obtained in treating standard pieces in a similar manner.

The term "work" is not necessarily used in its strictly scientific definition, but is used to denote the product or results of two or all of three factors, of which one is the force necessary to punch a hole of given size. cut a given indenture, or drift a given hole to enlarge it a given amount; another is the space through which the force moves its point of application during the act of punching, cutting or drifting, and the third is the time during which the force acts in the cutting, punching or drifting. In the practice of the method also, a combination of the first of these factors (the force) with the second or third is often used; and, in fact, it is a combination of the force with the space through which the force moves its point of application that the author has, so far as his experience has gone, proved to be the best and most accurate way of using it.

The most convenient way to measure these factors of the "work" done, the writer has found to be by graphical representations upon plotting paper, where the ordinates represent the force in pounds and the abscissae represent the increments of space through which the force moves its point of application in punching, cutting or drifting; or by graphical cards in which the ordinates represent the force in pounds and the abscissas the increments of time during which the force is acting. Such methods of recording are familiar to engineers and need no further description. Of course, in both of these species of curves, the indications of the abscissae and ordinates may be reversed, so that the abscissae will indicate the force in pounds and the other factor of the work shall be indicated by the ordinates.

In punching, cutting or drifting by this method of testing, specimens of hard steel, i. e., steel deficient in ductility will yield very slight indications of being acted upon by the working tool, up to a much higher pressure than that required for such indication in treating specimens of softer or more ductile steel. If curves be plotted or drawn in which, as above described, the ordinates indicate the force applied and the abscissas the amount of cutting or the time of operation of the tool, the tool will be seen to have produced much less indentation in the metal under the lower loads with hard than with soft steel, and, in the case of the hard metal, the curve will much more closely approximate the perpendicular or ordinate than with the soft metal.

Where the mechanism is so arranged as to plot a closed diagram, with the ordinates indicating the force applied and the abscissas indicating the space through which the force is applied or the time during which it acts, the upright lines of such diagrams in the case of the less ductile steel will be much more nearly perpendicular and parallel to each other than in diagrams obtained in testing softer specimens; they will also be higher because of the greater force required to act thus upon the metal. In a general way, also, the areas enclosed by the curves of such hard pieces of steel will be less than with soft specimens.

The reason for this is, that with softer and more ductile steel the indenting work of the tool is more uniform, beginning with the exertion of a lower force, and increasing gradually as the force applied increases; but with harder and less ductile steel comparatively little action is produced by the tool until the pressure reaches a high point, when, with much greater abruptness, the punching or cutting tool pierces the metal.

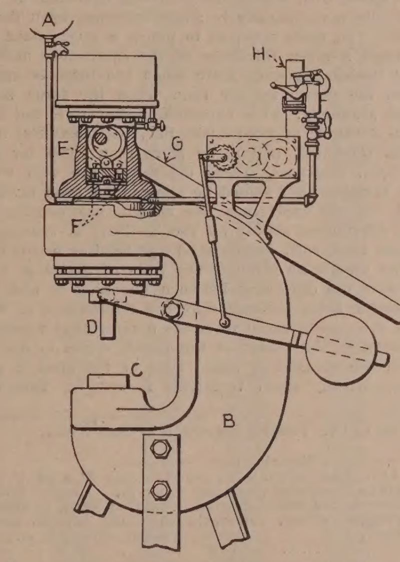


Fig. 1. Proposed Apparatus for Making Punching Tests.

In Fig. 1 an apparatus is shown for the general purpose of carrying on this method of testing. The apparatus consists of an hydraulic punch, having a main frame, marked 'B'; a die or anvil for the punch, marked 'C,' on which the specimen to be punched is placed; the punch marked 'D,' which is at the end of the hydraulic piston marked 'E;' the valves of which are marked F; the lever actuating the punch is marked G; the mercury gage is shown only in quarter outline, and is marked 'A.' The connection with the indicator of the apparatus as used, preferably when steam is used in the punching cylinder, is evident by inspection of the drawing. The drum upon which the pencil works is marked H.

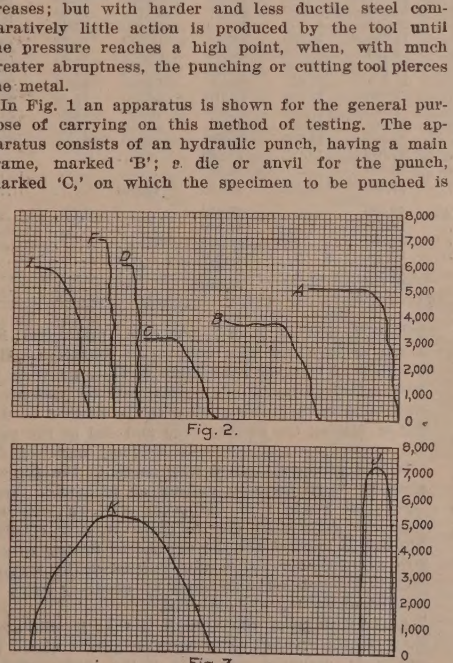


Fig. 2.

Fig. 3.

Figs. 2 and 3. Diagrams Obtained in Punching Steel of Various Qualities

Figs. 2 and 3 show copies of forms of curves upon specimens of 7-16 in. thick steel, with the exception of sample C, which was five-sixteenths in. thick. The test curves, marked A, B and C, are of soft steel, and D, F and I are harder grades of steel; C is of the softest basic steel, about 46,000 lbs. tensile strength per sq. in.; B of 50,000 lbs.; A of 69,000 lbs.; D, 78,000 lbs.; F of 85,000 lbs., and I of 75,000 lbs. In Fig. 3 the pencil was controlled by a spring, forming recurrent curves; specimen J being of 78,000 lbs. tensile strength, with 14% elongation in 8 ins., and specimen K of 65,000 lbs. tensile strength, with 24% elongation.

By this method tests can readily be made upon crop ends of pieces rolled from each ingot of steel used in any given lot of material; or, if necessary, pieces can be tested from crop ends taken from each end of large plates or bars, or from the bars and plates themselves. This ease of procuring samples and making the tests, and the absence of any large special expense therein, constitute a marked practical advantage for this method of testing. In fact, it will be perfectly practicable to equip the punches used at bridge and boiler shops in actual practice with some device for measuring the force or work done in punching; and by the aid of graphical devices a record can be kept of the characteristics of every piece of metal punched that goes into any structure. In this way, it is the writer's judgment, that a more accurate and satisfactory system of testing can be carried on than is possible with methods in general use at present.

It is not to be inferred by this that the need of careful inspection at the mills will be done away with by the adoption of this method of testing; on the contrary, with the general adoption of steel to replace wrought iron in structures, there is, and probably will remain, a constant necessity for careful supervision by unprejudiced and skillful inspectors employed by and in the interests of the purchaser and not of the mills themselves, in order to insure suitable material, and this, too, at the largest and best appointed and managed steel mills of the country, as well as the less experienced and smaller plants. This opinion is expressed after an extended experience with the methods, shop practice and character of the material turned out at most all of the structural steel works of the country.

The characteristics of the metal actually developed by this method of testing are: Its ductility as compared with its tensile and shearing strength. Experiments also show that a method of selecting good structural steel, and discarding that which is unsuitable, can be devised by means of this method of testing its quality.

From the record of the experiments given (and in accordance with the writer's experience) it will be seen that good steel within the limit of 55,000 to 65,000 lbs. tensile strength per sq. in., with an elongation of over 23% in 8 ins., a percentage of reduction of area of over 45%, and which pulls apart in tensile tests with a silky fracture, will require for ¾-in. punched holes (with centers 1½ ins. from the edge of the specimen, when the specimen is punched in between 30 to 60 seconds' time by a force applied gradually with a punch having ⅛ in. clearance), a force proportioned to the thickness of the plate or bar, as follows:

Thickness.						
3/16-in.	section,	between	20,000	and	24,000	lbs. pressure.
¼	"	"	25,000	"	30,000	"
5/16	"	"	33,000	"	40,000	"
⅜	"	"	40,000	"	46,000	"
7/16	"	"	48,000	"	55,000	"
½	"	"	56,000	"	63,000	"
9/16	"	"	65,000	"	73,000	"
⅝	"	"	73,000	"	80,000	"
11/16	"	"	80,000	"	88,000	"
¾	"	"	85,000	"	95,000	"

Similarly, the work done in punching a ¾-in. hole, under similar conditions to those stated above, can be measured with various thicknesses of section of structural steel, and the specifications may require that it shall be at least equal to the minimum amount in the following table, where the force used as one factor in obtaining the work shall be, as a minimum, in accordance with the results given in the corresponding column:

		Minimum work in inch pounds must be—	Where the force applied shall be at least—
¼-in.	section	3,125 lbs.	25,000 lbs.
5/16 "	"	8,250 "	33,000 "
⅜ "	"	10,000 "	40,000 "
7/16 "	"	12,000 "	48,000 "
½ "	"	14,500 "	56,000 "
9/16 "	"	17,500 "	65 000 "
⅝ "	"	19, 00 "	73,000 "
11/16 "	"	23,000 "	80,000 "
¾ "	"	25,000 "	85,000 "

In another way, the work done in punching ¾-in. holes, under conditions similar to those given above, can be used as a means of specifying suitable structural steel, as shown by the graphical methods of representing the work done in punching in Fig. 3; by stipulating that under given specified conditions the work done, as measured by the area of cards produced under given specified conditions for each given thickness, shall have a minimum area in square inches equal to given amounts when the vertical height of the figures produced in measuring the work are no more than given amounts.

The writer has no doubt but that other and perhaps better methods will be devised for measuring the force or work applied in punching, cutting, indenting, or drifting the samples to be tested, and undoubtedly the limits advised in this paper for the requirements for specifications will have to be revised as more experience is gained and more workers give their attention to the problems involved. The writer by no means wishes to claim that either perfection or the most accurate results have been arrived at in the matter of devising the best methods of applying this suggested new method of testing; on the contrary, better quick-acting machines, where the friction has been balanced or reduced to a minimum by special mechanism, and where new means entirely may be employed to measure and record the results as well as to perform the several operations will undoubtedly be invented and adopted, should the method become of general use; and, indeed, while the results given in the appendices following this paper are by no means all the results in each line which have been made, they have been chosen as typical results of the entire series. At the same time the writer freely acknowledges that it will take a large number of tests and more workers in the field to give a sufficient amount of data upon which to generalize or to give results which can be safely recommended for specifications upon which important work is based, in the selection of steel for engineering purposes.

The writer's only claim is, that the general principles involved in this proposed method of testing are of more quick application than any other, and indicate and measure in perhaps a better way the qualities in structural steel that are desirable, as well as the undesirable attributes that the material may have which would make it unsuitable to be used for its designed purpose. It is not claimed that by the use of the proposed formula the method will give in all cases the tensile strength of the metal, but rather that it suggests a method of testing for that combination of strength and ductility desirable in structural steel. It does not, for instance, necessarily distinguish steel of over 65,000 lbs. from that of a higher tensile strength unless the ductility is correspondingly low. Steel of 70,000 lbs. tensile strength, with 27% elongation in 8 ins., might be accepted by the method of testing suggested, in the place of a maximum 65,000-lb. steel of some specifications, on account of the exceedingly good ductility of the specimen referred to; though such a steel could not be accepted under this method of testing when the work is used as the crucial test, and the stipulation is made that the work shall be at least a minimum amount, the force as one factor of the work not being over a given stipulated amount. But steel with 70,000 lbs. tensile strength with only 18% elongation in 8 ins. would be rejected, as shown by comparing the demands of the foregoing tables for proposed specifications for structural material, with the results from such steel as shown in the table of Series 4.

This, the writer believes, is as it should be. A higher tensile strength steel, if accompanied with good ductility, as measured by stretch and reduction in tensile tests, should be accepted and not rejected, and the fact that this method of testing would include such steel is, in the writer's judgment, a point in favor of this method of testing. Again, where the section is over ⅝-in. thickness, the crushing strength seems to be exceeded in the bottom portion of the punched metal, and the walls of both the hole and punching show markedly the line of demarcation between the sheared and the crushed surfaces of the metal. The force applied in punching seems to vary much more with steel of over ⅝-in. thickness for varying factors of speed of the punching operation, character of the punch, and similar occasions for the variance of the results of the punching test; and the author does not claim from his experience that the same degree of accuracy can be obtained by this method of testing sections of over ⅝-in. thickness as with thinner sections with the forms of apparatus already devised.

With the results given in Series 8, it is shown that the speed with which the punching operation is done has only a comparatively slight influence upon the results. The force required to punch a given sized hole through a given thickness of the same steel being a few thousand pounds more when the force is applied upon the punch quickly than when the force is applied gradually. This variation, however, is not more than 2,000, or at most 3,000, lbs., with material up to ⅜-in. thickness, and is no more than 5,000 for steel of ⅝-in. thickness. These differences are well within the variance that should be allowed for good material, and, as our experience has shown, are nothing like the differences shown by the methods of testing between good, soft, ductile steel and hard or brittle steel.

The results as given in the tests of Series 2, 3 and 8 show the difference between punching ¾ and ⅞-in diameter holes through different thicknesses of steel, and the results given in Series 9 show that where the location of the center of the punch varies in distance from the sheared or rolled edge of the steel it gives comparatively small variations in results. This table indicates that with ordinary care, precaution being taken to have the tools uniform in character and the methods of working reasonably similar, no wide variance or discrepancy of results will be encountered. The same remark also applies to the method of dressing or arming the cutting edge and end of the punching or cutting tools. Widely varying ways of doing this will produce marked differences in the force applied or work done in cutting or punching, through equivalent sections of the same steel. At the same time the differences due to these varying conditions are not so marked nor the method of testing so sensitive as to render the results untrustworthy when ordinary precautions necessary to accuracy with any method of testing are observed.

An advantage of the system is that it will always be perfectly practicable to keep, at places where tests are made standard specimens of the thicknesses generally worked upon, which have been tested by other machines and under other conditions, and of which full records of results are ready for comparison; and at any time questions as to the apparatus in use being out of order or giving discordant results can be readily proved by making tests with the standard specimens to check the working of the apparatus.

With the necessary precautions being taken that have been explained in this paper, it is the writer's judgment that this system of testing the quality of steel can be safely and conveniently used for structural purposes, and that it is sensitive enough and will exclude all classes of bad steel, and that which is unsuitable. It will, of course, take a large amount of testing and experience to develop all the facts regarding this. In a general way, however, the writer believes that, especialy where specifications for structural steel are drawn requiring a minimum work where the actual force applied as one of the factors of the work is within given limits for each varying thickness of section, the results obtained by the method can be safely relied upon to reject, not only steel that will be too hard or too soft, but also that which will be too brittle or too weak, or that which has been burned, or steel that has not had a sufficient amount of "work" —in short, that it will reject metal that has any of the injurious qualities that steel is ordinarily rejected for, as regards its physical properties.

TABLE I.—Showing the Relation of the Shearing to the Tensile Strength of Soft Steel.

		Tensile test.				Shearing test.					
Description.	Diameter.	Elastic limit lbs. per sq. in.	Ultimate strength lbs. per sq. in.	Elongation in 8 ins. P. c.	Reduction of area. P c.	Lbs. actual exerted in single shear.	Lbs. actual exerted in double shear.	Lbs. per sq. in. exerted in single shear.	Lbs. per sq. in. exerted in double shear.	P. c. of single shear to tensile strength.	P. c. of double shear to tensile strength.
⅝ in. rod	0.625	......	57,910	.....	57.62	......	......	44,330	......	76 55	......
" "	0.625	......	57,910	.....	57.62	......	......	45,310	......	78.24	......
" "	0.625	......	56,780	.....	62.17	......	......	44.000	......	77.50	......
" "	0.625	..	56,780	.....	62.17	......	......	43,840	......	77.21	.....
⅞-in. rod	0 858	43 590	61,400	30.5	59.52	27.100	52,250	46 870	45,180	76.34	73.60
" "	0 857	43,250	58,770	31¼	60.30	26,900	51,450	46,640	44 600	79.33	75.90
" "	0.860	42,520	60,170	20.0	60.00	26,700	52,000	45,960	44,760	76.38	74.39
" "	0.855	42.240	60,970	30.0	60.84	26,200	51,600	45,640	44,950	74.86	73.56
¾ in. rod	0 745	44,970	66,300	29¼	51.46	20,450	42,350	46.910	48,580	77.75	73.28
" "	0.745	44,960	66,070	25.0	57.98	20,200	42,250	46,340	48,410	70.15	73.26
" "	0.743	42,960	61,810	27¾	58.44	20,000	39,200	46,130	45,200	74.68	73.13
" "	0.756	42,990	61,700	29.5	61.35	21,550	41,700	48.010	46,450	77.81	75.94
⅝-in. rod	0.642	42,010	60,650	27.5	63.11	14,700	31,100	45,410	48 040	75.00	79.35
" "	0.642	42,010	60,860	29.5	62 52	14.100	30,150	43,560	46,570	71.58	76 52
" "	0.634	43,390	56,700	22.5	59.20	14.700	27,450	46,560	43,470	82 12	77.55
" "	0.634	40,220	56,060	28¾	58.18	14,650	27,650	46,400	43,790	82.76	78.11
½-in. rod	0.510	48,950	65,100	22.0	44.78	9,700	17,550	47,470	42,950	72.92	65.98
" "	0.509	46,680	64.870	27.0	42.21	9.400	17,750	46,190	43,620	71.21	67.24
¾-in. rod	0.756	44,550	61,040	27.0	62.98	20,950	40.950	46,670	45,610	76.48	74.80
" "	0.757	43,550	60 880	27.5	58.07	20.550	40 700	45,660	45,220	74.84	74.26
⅞-in rivet	0.875	......	......	....	.....	27,200	......	45,230	......	.....	.....
" "	0.878	......	......	....	.....	24,500	......	40,460	......	.....	.....
" "	0.865 S.S. 0.871 D.S.	....	......	....	.....	26,100	53,200	44,460	44,640	.....	.....
¾-in. rivet	0.752	......	......	....	.....	19,300	......	43,470	......	.....	.....
" "	0.764	......	......	...	.....	19,000	......	41 450	......	.....	.....
" "	0.761	......	......	....	.....	22,000	......	48,380	......	....	.....
" "	0.767	......	......	....	.....	20.800	......	45,020	......	.....	.....
⅝-in. rivet	0.637	......	......	....	.....	14,650	......	45 960	......	.....	.....
" "	0.636	......	......	....	.....	14,150	......	44,540	......	.....	.....

The several series of tests given by Mr. Hunt to support the statements advanced in the foregoing are each accompanied by tables of considerable length. Those accompanying Series 1, 2, 3, 4 and 5 are given nearly in full; and that accompanying Series 6 in part, while the results of the tests as summarized by the author are given for Series 7, 8 and 9.

Series 1.—To determine the Relation of Shearing to Tensile Strength samples of ½, ⅝, ¾ and ⅞-in. diameter round rods of soft steel were taken by the writer for experiments, care being taken in each instance to know the rods were each from homogeneous and uniform melts of steel that had previously been ascertained by frequent tests to be of good representative quality of that used in ordinary structural work, most of it being of a character used in the fabrication of rivets.

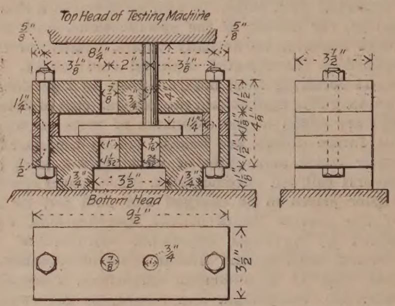


Fig.4. Apparatus for Punching Tests.

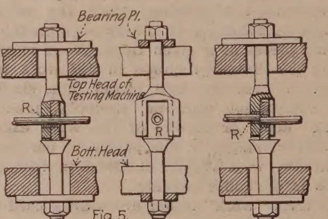


Fig.5. Fig. 6.

Single Shear.

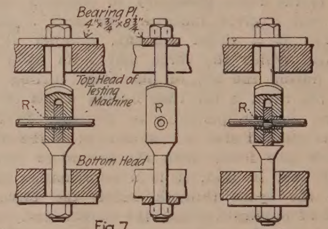


Fig.7. Fig.8.

Double Shear.

Figs. 4 to 8. Apparatus Used for Shearing and Punching Tests.

One or more portions of each rod were pulled apart in the 100,000-lb. Olsen testing machine of the Pittsburg Testing Laboratory, and the ordinary tensile test results obtained are recorded in Table I.

Adjoining portions of the same rods were sheared apart, either in single or double shear, in an apparatus in use by the writer at the Pittsburg Testing Laboratory, and which is shown in Figs. 5, 6, 7 and 8. The opposite ends of the apparatus were, in most instances, held between the upper fixed and lower movable cross-heads of the Olsen testing machine of the Pittsburg Testing Laboratory, although corroborative check results were obtained by use of the same apparatus attached to the heads of an 100,000-lb. emery machine.

The bearings or cutting edges of the shearing apparatus are rings R of Figs. 5, 6, 7 and 8, and are of specially prepared hard tool steel. Concordant, and the writer believes accurate, results were obtained in all the tests recorded in Table 1, great care being taken to insure the specimens being sheared directly in line without unnecessary bending movements, and with precautions to keep friction at a minimum.

TABLE II.—SHOWING RESULTS OBTAINED FROM VARIOUS QUALITIES OF STEEL IN DETERMINING PRACTICABILITY OF PUNCHING AS A METHOD OF TESTING THAT METAL FOR STRUCTURAL PURPOSES.

Sp'c'men number.	Description cut from— (Ins.)	Th'kness of speci-men. Ins.	Tensile strength.				Punching tests.		Results obtained by calculation.				Analyses of steel.		
			Elastic limit per sq. in.	Ult. strength per sq. in. U.	Elong. in 8 in. P. c.	Reduc. of area, P. c.	Pres. applied in lbs. to punch. ¾-in. diam. punch. P.	Pres. applied in lbs. to punch. ⅞-in. diam. punch. P.	$\frac{P}{c \times t}$ with ¾-in. diam. punch. c = 2.5133.	$\frac{P}{c \times t}$ with ⅞-in. diam. punch. c = 2.9217.	P. c. $\frac{P}{c \times t}$ is to ulti. strength. ¾-in. diam. punch.	P. c. $\frac{P}{c \times t}$ is to ulti. strength. ⅞-in. diam. punch.	Carbon, P. c.	Mang. P. c.	Phos. P. c.
Series 2.—Tests of Soft Steel Between 50,000 Lbs. and 70,000 Lbs. Tensile Strength.															
1	6¾ × 3/16 Pl.	0.185	48,360	65,720	20.00	57.04	21,600	25,200	46,450	46,610	70.68	70.92	0.12	0.50	0.064
	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
2	2 × 2 × 3/16 L.	0.187	46,200	66,200	21.30	58.10	23,500	27,500	50,000	50,320	75.54	76.10	0.22	0.51	0.021
	"	"	"	"	"	"	"	"	"	"	75.52	"	"	"	"
3	3 × 3 × ¼ L.	0.245	41,770	61,590	25.00	51.90	28,300	81,800	45,960	44,430	74.64	82.74	0.11	0.46	0.086
	"	"	"	"	"	"	"	32,200	"	44,980	"	73.04	"	"	"
4	15 × ¼ Pl.	0.256	42,200	63,500	25.80	56.30	29,800	33,500	46,320	44,780	72.94	70.52	0.24	0.44	0.018
	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
5	3 × 3 × 5/16 L.	0.310	38 900	60,970	25.00	53.80	37,000	41,300	47,500	45,830	77.91	75.16	0.10	0.46	0.084
	"	"	"	"	"	"	36,800	"	47,240	"	77.48	"	"	"	"
6	62 × 5/16 Pl. 136	0.320	37,200	61,590	24.80	54.20	36,500	40,800	45,280	43,640	73.68	70.86	0.25	0.48	0.023
	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
	"	"	38,000	62,400	25.80	55.00	37,100	43,600	46,130	44,170	73.94	70.78	"	"	"
	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"
7	10½ × ⅜ Pl.	0.365	38,630	58,370	25.00	62.50	45,700	46,800	49,810	43,880	85.32	75.16	0.15	0.45	0.012
	"	"	"	"	"	"	44,000	48,900	47,960	45,850	82.12	78.54	"	"	"
8	10 × ⅜ Pl.	0.365	41,960	67,170	26.25	51.47	46,100	53,800	50 250	50,440	74.80	75.10	0.24	0.45	0.028
	"	"	"	"	"	"	45,800	53,000	49,920	49.700	74.32	73.99	"	"	"
	"	"	42,500	68,000	26.80	50.90	"	53,900	50.040	50,540	74.50	75.24	"	"	"
	"	"	"	"	"	"	"	"	49,920	"	74.32	"	"	"	"
9	10 × ⅜ Pl.	0.364	39,060	64,240	26.25	50.62	46,600	52,400	50,930	49,270	79.28	76.70	0.27	0.42	0.017
	"	"	"	"	"	"	46,300	52,100	50,600	49.010	76.29	76.24	"	"	"
	"	"	38,200	53,500	26.00	51.30	46,000	52,000	50,270	48,900	76.12	77.00	"	"	"
	"	"	"	"	"	"	46,100	51,800	50,380	48,710	75.82	76.70	"	"	"
10	10 × ⅜ Pl.	0.370	32,100	50,800	29 80	72.10	39,800	45,100	42,800	41,720	84.26	82.10	0.13	0.29	0.018
	"	"	"	"	"	"	40,200	45,300	43,230	41.900	85.90	82.48	"	"	"
11	"	0.360	42,820	70,790	23.75	51.70	48,100	54,500	53,160	51,810	75.10	73 21	0.19	0.49	0.071
	"	"	"	"	"	"	"	54,800	"	52,100	"	73.60	"	"	"
12	25 × 7/16 Pl.	0.430	40,350	61,910	28.00	53.80	50,200	58,200	47,370	46,410	76.50	74.98	0.15	0.33	0.074
	"	"	"	"	"	"	51,600	58.400	47,330	46,490	77.10	75.09	"	"	"
13	4 × 4 × 7/16 L.	0.438	42,000	63,500	24.60	50.30	54,000	62,100	49,650	48,530	77.24	76.43	0.14	0.43	0.081
	"	"	"	"	"	"	53,800	61,800	48 870	48,290	76.36	76.05	"	"	"
14	20 × ½ Pl.	0.500	39,360	61,990	26.00	52.30	60,300	66,900	47,580	45,790	77.27	73.88	0.21	0.42	0.011
	"	"	"	"	"	"	59,400	68,100	47,270	45,240	77.26	73.99	"	"	"
15	16 × ½ Pl.	0.505	37,300	55,900	27.30	64.20	56,900	64,800	44,840	43,920	80.21	78.56	0.10	0.36	0.073
	"	"	"	"	"	"	57,200	65,300	45,070	44,260	80.62	79.17	"	"	"
16	5 × 3½ × ½ L.	0.536	39,210	59,900	26.20	58.30	62,000	70,100	46,020	44,770	76.83	74.74	0.12	0.37	0.062
	"	"	"	"	"	"	62,100	69,400	46,100	44,320	76.96	73.99	"	"	"
17	6 × 6 × 9/16 L.	0.580	39,480	62,380	26.25	55.30	70.000	79,000	48,020	46,620	76.98	74.74	0.15	0.54	0.097
	"	"	"	"	"	"	69,000	78.300	47,340	46,210	75.89	74.08	"	"	"
18	6 × 6 × 9/16 L.	0.555	38,710	60,910	25.00	54.40	67,100	76,400	48,100	47,110	78.97	77.34	0.13	0.32	0.103
	"	"	"	"	"	"	65,700	76 100	47,090	46,930	77.32	77.06	"	"	"
19	18 × 9/16 Pl.	0.560	36,430	63,290	28.50	59.93	61,000	71,400	43,340	43,640	68.48	68.95	0.16	"	0.089
	"	"	"	"	"	"	62,000	71,500	44,050	43,710	69.60	69.06	"	"	"
20	5 × 5 × ⅝ L.	0.600	39,440	62,380	25.00	50.70	74,000	83,300	49,070	47,520	78.66	76.18	0.10	0.50	"
	"	"	"	"	"	"	74,300	83,200	49,270	47,460	78.98	76.10	"	"	"
21	10 × ⅝ Pl.	0.620	43,000	69,500	23.80	48.60	75,900	84,600	48,720	46,700	70.10	67 20	0.18	0.39	0.077
	"	"	"	"	"	"	75,400	86.200	48,400	47,580	69.64	68.46	"	"	"
22	6 × 6 × 11/16 L.	0.670	40,700	61,100	23.75	56.20	86,000	93,100	51,070	47,590	83.58	77.89	0.16	0.69	0.105
	"	"	"	"	"	"	85,500	93,700	50,830	47,870	83.25	78.34	"	"	"
23	18 × 11/16 Pl.	0.690	37,500	56,200	24.80	53.90	80,500	89,100	46.420	44,200	82.20	78.65	0.17	0.49	0.082
	"	"	"	"	"	"	80,200	89,000	46,260	44,150	82.32	78.56	"	"	"
24	4 × 4 × ¾ L.	0.725	33,330	60,160	28.75	54.90	82,000	97,300	45,010	45,930	74.82	76.34	0.15	0.45	0.009
	"	"	"	"	"	"	83,800	95,700	46,000	45.650	76.40	75 88	"	"	"
25	10 × ¾ Pl.	0.755	27,090	63,390	30.00	62.00	83,000	92,000	43,740	41,670	72.44	69.00	0.13	0.58	0.060
	"	"	"	"	"	"	85,000	99,000	44,800	44.840	74.24	74.25	"	"	"
26	10 × 13/16 Pl.	0.817	......	......	.....	.....	90,300	97,500	43,980	40,850	.....	.....	"	0.53	0.077
	"	"	......	......	.....	.....	88,100	100,400	42,920	42,060	.....	.....	"	"	"
27	6 × 6 × 13/16 L.	0.813	38,200	62,400	24.30	52.00	93,000	101,900	45,520	42,910	72.96	68.76	0.19	0.37	0.028
	"	"	"	"	"	"	94,000	100,700	46,020	42,400	73.74	67.95	"	"	"
28	24 × ⅞ Pl.	0.880	32,650	57,870	27.00	59.00	101,000	114,000	45,640	44,340	78.86	76.62	0.25	0.51	0.009
	"	"	"	"	"	"	....	107,000	......	41,630	.....	71.94	"	"	"
29	18 × ⅞ Pl.	0.876	34,000	64,800	23.80	51.10	105,000	119,000	47,680	46,500	73.59	71.76	0.27	0.37	0.021
	"	"	"	"	"	"	103,000	121,000	46,800	47,290	72.22	72.90	"	"	"
30	6 × 6 × 15/16 L.	0.910	......	......	......	.....	....	119,000	......	44,760	.....	.....	0.11	0.58	0.092
31	"	0.938	34,500	62,100	23.00	48.00	117,000	120,000	49.630	43,800	79.92	70.54			
	"	"	"	"	"	"	110,000	"	46,660	"	75.16	"			
32	21 × 1 Pl.	1.010	38,270	56,320	30.50	53.30	....	121,000	......	41,010	.....	72.82			
	"	"	"	"	"	"	....	"	......	"	.....	"			
33	15 × 1 Pl.	1.008	35,650	57,200	23.80	47.90	113,000	124,000	44,620	42,116	78.01	73.62	0.23	0.39	0.025
	"	"	"	"	"	"	115,000	126,000	45,410	42,780	79.32	74.79	"	"	"
Series 3.—Tests of Steel of Extra Purity, Quality and High Ductility.															
1	10 × ⅜ Pl.	0.365	44,220	73,600	24.25	50.67	46,600	52,100	50,800	48,900	69.02	66.37	0.17	0.55	0.041
1	"	"	"	"	"	"	46,600	53.000	50,800	49,750	69.02	67.53	"	"	"
2	10 × ⅜ Pl.	0.360	40,820	70,790	25.75	51.77	48,100	54,900	53,160	52,200	75.10	73.74	0.18	0.51	0.037
2	"	"	"	"	"	"	47,900	54,700	52,940	52,000	74.78	73.45	"	"	"
3	10 × ⅜ Pl.	0.367	42,060	70,170	25.75	50.99	47.500	52,800	51,500	49,240	73.39	70.17	0.16	0.49	0.042
3	"	"	"	"	"	"	46,800	52,900	50,740	49,340	72.31	70.32	"	"	"
4	5 × 3½ × ½ L.	0.536	41,300	70,200	27.30	54.60	62.100	71,800	46.100	45,850	65.67	65.34	0.19	0.51	0.029
4	"	"	"	"	"	"	61,800	71,900	45,870	45,920	65.34	65.41	"	"	"
5	5 × ½ bar.	0.505	47,900	82,400	25.10	52.25	64,900	73,400	51,720	49,750	62.04	60.38	0.24	0.48	0.031
5	"	"	"	"	"	"	65,200	73,500	51,360	49,810	62.33	60.45	"	"	"
6	6 × 6 × 9/16 L.	0.561	45,000	78,800	26.25	54.00	68,800	76,300	48,790	46,550	61.92	59.07	0.20	0.59	0.035
6	"	"	"	"	"	"	69,000	76,800	48,940	46,850	62.11	59.45	"	"	"
Series 4.—Tests of Hard and Brittle Steels.															
1	10 × ⅜ Pl.	0.361	49,900	71,200	16.30	30.80	60,400	67,900	66,570	64,370	93.50	90.42	0.16	0.90	0.087
1	"	"	"	"	"	"	61,000	68,300	67,240	64,750	94.44	90 95	"	"	"
2	12 × ⅜ Pl.	0.369	55,100	74,100	13.20	21.10	64,200	71,800	69,230	66,610	93.45	89.90	0.21	0.65	0.091
2	"	"	"	"	"	"	64,000	71,500	69,010	66,330	93.14	89.53	"	"	"
3	4 × 4 × 7/16 L.	0.435	48,200	82,200	8.10	15.10	80,300	87,100	73,460	68,530	89.36	83.39	0 26	0.53	0.115
3	"	"	"	"	"	"	81,000	87,500	74,090	68.840	90.13	83.75	"	"	"
4	6 × ½ Pl.	0.515	43,400	70,800	18.80	28.90	70,900	78,300	54,780	52,040	77.37	73.50	0.18	0.57	0.091
4	"	"	"	"	"	"	73,000	80,100	56,400	53,240	79.66	75.20	"	"	"
5	3½ × 3½ × ½ L.	0.505	46,300	76,400	18.10	29.50	75,300	82,900	59,340	56,190	77.67	74.53	0.15	0.51	0.125
5	"	"	"	"	"	"	77,000	84,500	60,670	57,280	79.41	74.98	"	"	"
6	15 × ½ Pl.	0.518	58,000	79,900	10.30	16.30	84,900	94,700	65,210	62,570	81.61	78 31	0.17	0.41	0.145
6	"	"	"	"	"	"	81,000	95,000	62,220	62,770	77.87	78.57	"	"	"
7	4 × ⅜ Pl.	0.390	......	125,800	in 2″ = 7.50 " 3″ = 6.67 " 4″ = 6.25 " 5″ = 6.00 " 6″ = 7.50	4.41	87,000	98,000	88,760	86,020	70.56	68.37	0.71	0.14	0.079
Series 5.—Tests of Weak and Rotten Steels.															
1 (a)	2 × 3 × 5/16 L.	0.313	30,100	47,800	19.80	38.50	30,100	34,400	38,270	37,615	80.06	78.49	0.12	0.31	0.095
1	"	"	"	"	"	"	29,700	33,500	37 760	36,640	79.00	76 65	"	"	"
2 (b)	3 × 3 × ⅜ L.	0.390	35,400	61,000	8.50	12.20	37,400	42,000	38,160	36,860	62.56	60.45	0.10	0.14	0.072
2	"	"	"	"	"	"	36,700	42,500	37,440	37,300	61.34	61.14	"	"	"
3 (a)	3 × 3 × ⅜ L.	0.379	32,500	48,900	17.50	33.10	39,900	44,700	41,890	41,650	85.68	85 18	0.14	0.377	0.101
3	"	"	"	"	"	"	40.300	45,500	42,310	42.400	86.52	86 70	"	"	"
4 (c)	16 × 7/16 Pl.	0.445	30,900	48,300	16.30	31.20	45,500	50,200	40,680	38,610	84.22	79.94	0.087	0.229	0.041
4	"	"	"	"	"	"	44.900	50,000	40,140	38,450	83.11	79.60	"	"	"
5 (c)	20 × ½ Pl.	0.523	32,200	46,000	18.90	31.90	50,800	56,400	38,650	36,920	84.02	80.26	0.067	0.12	0.065
5	"	"	"	"	"	"	50,200	56,100	38,190	36,720	83.02	79.83	"	"	"
6 (d)	10 × ¾ Pl.	0.770	37,400	58,800	15.25	36.50	62.000	72,000	32,040	32,010	54.49	54 43	0.16	0.29	0.055
6	"	"	"	"	"	"	64,000	71,000	33,080	31,570	56.26	53.69	"	"	"
7 (d)	12 × ⅞ Pl.	0.900	39,800	64,300	17.10	28.20	......	74,000	......	28,150	.....	43 78	0.19	0.34	0.063
7	"	"	"	"	"	"	......	75,000	......	28,530	.....	44.37	"	"	"
8 (b)	7 × 13/16 Pl.	0.810	......	......	.....	.....	90,000	......	44,210						

(a) Poorly made; (b) burned; (c) weak; (d) not sufficiently worked.

The results indicate that somewhat greater shearing strength is shown in single than in double shear with the method of testing adopted. An average of 16 results of specimens Nos. 3 to 18 inclusive, give the shearing strength in single shear as 75.46% of the ultimate tensile strength, and only 73.56% in double shear. This is probably due to increased bending moments in the case of the specimens subject to double shear. Still, as the rods very closely filled the holes in the cutting rings in each instance, and the distance between shearing planes was 1 in., the conditions were very similar to the strains of double shear produced on rivets in actual practice.

The results, as a whole, show that the usual stipulations in engineering specifications, and the practice of allowing a unit strain in structural steel subject to shearing stress of 80% of that allowed in tension, is probably too liberal, and that it should be reduced to about 70% in metal subject to double shear, and not over 75% in that subject to single shear.

Series 2.—The punching apparatus used for the major portion of the tests given in Table II., and, in fact, in the punching results of the other tables, is shown in Fig. 4. It consists of two plates of steel 1½ ins. thick, which are held apart by 1⅛-in. blocks and bolted securely together with two ½-in. bolts at either end. The length of the apparatus is 9½ ins., the base plate having 1¾-in. projections upon which the apparatus rests. The plates are pierced with two holes for a ¾-in. punch in one instance, and a ⅞-in. punch in the other. The diameter of the lower dies is from 1 to 1 and 1-32 in. for the ⅞-in. punch, and from ⅞ to 20-32 in. for the ¾-in. punch.

As the apparatus is arranged in Fig. 4, the plate to be punched is placed in position and the ¾-in. punch is placed upon it, the whole apparatus setting upon the bottom plate of the testing machine, from which the pressure applied is transmitted through to the weighing apparatus of the machine, the top head of the machine pressing directly upon the top of the ¾-in. punch. The other general dimensions are shown by inspection of Fig. 4.

The power required in punching samples of good structural steel is shown in Table II. The specimens were selected as those having a tensile strength of between 50,000 and 70,000 lbs. per sq. in., with good ductility. Punching tests were made from the same material, with both the ¾ and ⅞-in. punches in most instances. The power was applied and measured in these tests of Table II. upon an Emery 100,000-lb. capacity testing machine in all cases, except in the three specimens of which four tests each were made, in which the first and second results were measured on the Emery testing machine, and the third and fourth on a 100,000-lb. Olsen testing machine of the Pittsburg Testing Laboratory. The legend of this table is as follows: U = ultimate tensile strength per sq. in. S = shearing strength per sq. in., as obtained by getting 75% of the tensile strength. P = pressure applied in pounds to punch the material. c = average circumference of the punching. t = thickness of the specimen punched. The shearing strength per square inch is represented by the formula

$$\frac{P}{c \times t}.$$

Owing to the large clearance of the punching apparatus, the value of c, or the average circumference, was found to be very closely the same through the varying thicknesses of metal, and was taken for the ¾-in. punch to be 2.5133 ins.; and with the ⅞-in. punch, c, or the average circumference, was taken at 2.9217 ins.

By inspection of Table II. the increment due to increased thickness to produce the punchings is shown throughout to be more or less regular, although the increment varies more above the thickness of ⅝ in. than with thinner sections. The average increment of pressure is found to be, as an average of a large number of experiments, from 112 to 120 lbs. for each .001 inch added thickness for the ¾-in. diameter punchings, and from 133 to 137 lbs. similarly for the ⅞ diameter punchings in ordinary cases of good steel. The makes of steel of the various specimens were as follows:

Specimen 1, acid open hearth.
" 2, " "
" 3, " Bessemer.
" 4, basic open he'rth
" 5, acid Bessemer.
" 6, basic open he'rth
" 7, " "
" 8, " "
" 9, " "
" 10, " "
" 11, acid "
" 12, " "
" 13, " Bessemer.
" 14, basic open he'rth
" 15, acid "
" 16, " "
" 17, " Bessemer.
Specimen 18, acid Bessemer.
" 19, " "
" 20, " "
" 21, " open hearth.
" 22, " Bessemer.
" 23, " open hearth.
" 24, basic "
" 25, acid "
" 26, " "
" 27, basic "
" 28, " "
" 29, " "
" 30, acid "
" 31, " "
" 32, " "
" 33, basic "

Series 3.—These tests were made upon samples of steel of extra purity and quality, and which have exhibited very high ductility as compared to the ultimate strength in tensile tests. The results of 12 tests upon six different samples give, as an average of the percentages of the shearing strength per square inch of the ultimate tensile strength, 67.63% for the steel punched with ¾-in. punch, and 67.74% with the same steel punched with the ⅞-in. punch. All the specimens of steel were made by the acid open-hearth process. The results clearly show that with this class of steel the shearing strength per square inch, as determined by the formula $\frac{P}{c \times t}$ is a smaller percentage of the ultimate tensile strength, and the steel is not of so great comparative ductility, a state of affairs that by no means points necessarily to a poor quality of steel, and, in fact, in the particular steel under consideration, is an evidence of superior quality instead.

Series 4.—The tests of this series were made upon samples of hard and brittle steels, most of which owed their hard and brittle qualities to high carbon or high phosphorus, or a combination of the two, or to large proportions of manganese probably not uniformly distributed through the metal. In the case of hard and brittle steels, the results given in the table show that the shearing strength approaches much more nearly the tensile strength than with softer and more ductile metal. Specimens numbered 1 to 5 inclusive were of acid Bessemer steel. Specimen 6 was made by the basic Bessemer process, and specimen 8 was crucible steel.

Series 5.—These tests were made on specimens of steel which had proved weak and rotten in tensile tests. This steel had evidently never been properly refined, owing in the case of specimens 4, 5, 6 and 7, made by the acid open-hearth process, to a cold open hearth furnace, unskillful melting, failure of gas supply, or a similar cause, and in the case of the acid Bessemer steel specimens 1, and 2, to a bad pig iron mixture, working cold, a lack of wind pressure, or similar cause. The proportion between the shearing strength as determined by the formula $\frac{P}{c \times t}$ and the ultimate tensile strength varies greatly with this class of steel, due to the particular condition it may be left in. Some weak steels are superficially quite hard, while others are softer throughout than ordinary steel. In almost all cases the pressure applied is less in punching with this class of steel than with good steel, though this is not, in fact, the case with the samples of weak steel chosen for these particular tests. The experiments show that with weak and rotten steel of low tensile strength and ductility the relation of shearing to tensile strength is not uniform, and that, when the force applied to making the punching test is either abnormally low or high or irregular, there is no cause for further investigation of the metal.

Series 6.—For this series of tests a number of specimens of Series 2 were burned, and the power required to punch the burned specimens compared with that required to punch them in their original state. The tests showed an average decrease of the power required of 2.36% for the ¾-in. punch and 1.48% for the ⅞-in. punch. In Table 3 the variance in pressure with burned steel from that with the same steel in the normal state is shown in detail.

Most steels show a less tensile strength and take less power to punch after being burned. In other words, the steel is weakened and made rotten by burning. In some cases, however, owing probably to the occlusion and chemical combination of occluded gases, burned steel is rendered hard and brittle, although in such cases the author's experience has been that the elastic limit of tensile specimens very closely approaches the ultimate strength, and by the burning operation the character of the steel is made to approach that of cast iron.

Series 7.—These tests were undertaken to determine the action of the thickness of the specimen in punching. The records of tests of steel over ⅝-in. thickness so far made have not given as uniform results as similar results of steel of lower thickness. There seems to be a crushing action upon the lower sections of the metal, which seems to be plainly shown upon examination of both the walls of the punched holes and the punchings themselves. The tests have also shown the general shop rule to be a good one of never using a punch in steel of a thickness greater than the diameter of the punch. In several instances of punching up to ⅞ and 1 in. in thickness, the punches of ¾ in. diameter made of best steel failed, in most cases, by bending. As a general rule, material thicker than ⅝-in. requires a little lower pressure per square inch than thinner sections of the same steel, probably due partly to the crushing action of the lower part of the metal mentioned above, and partly to the fact that the thicker steel has not had proportionately so much work upon it in most cases and is not so strong, either in tensile or shearing strength, as the thinner rolled material.

The crushing noted above is liable to give irregular and misleading results as to the quality of the material tested. It is thought that in these cases a double set of punches working against each other will perhaps correct the trouble.

Series 8.—This series of tests was made to determine the action of the speed of punching in modifying the results.

A considerable number of specimens of steel were taken which had been proved to be very homogeneous throughout, and on which a good many results of punching tests had been obtained. These were again tested and the power applied in punching both ¾ and ⅞-in. holes was measured. The power was applied very gradually from 1 to 10 minutes' time being occupied in some cases, and in others, on thes same steel, performing the punching in from 10 to 60 seconds. This was done very accurately, with the aid of the rapid-working plunger of an Emery testing machine. In a general way, the pressure applied rapidly, as in 10 seconds, gives slightly lower results than when the same conditions are varied only by the time being considerably longer in applying the pressure upon the punch. The entire difference, however, is very slight, comparatively, and will not be a cause of error in this method of testing steel by any ordinary variances due to speed. Ten seconds is about as short a time as it is has been found practical to make a punching and record its results with the apparatus at the writer's command.

In general, the experiments show that the action of speed in punching does not modify the results to any considerable extent, especially where reasonable care is taken to have the testing conducted under uniform conditions in this respect.

Table 3.—Showing Variance in Pressure Required to Punch Burned Steel for That Required to Punch the Same Steel in the Normal State.

Description cut from—	Pounds variance, ¾-in. punch.	Per cent. with ¾in. punch of U.	Pounds variance. with ⅞-in. punch.	Per cent variance ⅞-in. punch of U.
¾ × $\frac{3}{16}$ in. Pl.	+ 160	70.92	−10 750	54.56
"	− 2 870	66.30		
3 × 3 × ¼ in. L.	+ 2 900	74.80	− 8 300	68.23
"	− 180	74.34	−12 550	61.33
3 × 3 × $\frac{5}{16}$ in. L.	− 2 030	74.58	− 1 510	72.70
"	− 1 960	74.28	− 360	71.58
10½ × ⅝ in. Pl.	− 1 470	82.82	+ 3 020	80.35
"	+ 1 700	85.08	+ 420	79.27
25 × $\frac{7}{16}$ in. Pl.	− 1 440	74.09	− 3 020	69.91
"	− 2 930	72.36	− 4 520	67.79
20 × ½ in. Pl.	− 340	76.86	+ 440	74.50
"	− 1 020	74.61	− 900	71.53
6 × 6 × $\frac{9}{16}$ in. L.	+ 730	78.15	+ 2 160	78.20
"	− 1 740	73.10	− 350	73.51
18 × $\frac{9}{16}$ in. Pl.	+ 210	68.81	− 120	68.76
"	+ 500	70.39	− 2 360	65.33
5 × 5 × ⅝ in. L.	− 1 310	76.55	− 1 430	73.81
"	− 2 110	75.60	− 1 700	73.26
6 × 6 × $\frac{11}{16}$ in. L.	− 1 960	80.43	+ 400	78.52
"	− 3 680	77.16	− 470	77.59
6 × 6 × $\frac{9}{16}$ in. L.	− 960	77.39	+ 3 260	82.70
"	+ 1 960	80.52	+ 320	77.57
4 × 4 × ¾ in. L.	− 4 240	67.77	− 4 050	69.62
"	− 5 400	67.57	− 5 620	66.54
"	....	65.74		
10 × ¾ in. Pl.	+ 2 190	77.72	+ 3 570	74.91
"	− 3 470	68.44	− 10	74.23
"	....	72.15		
10 × $\frac{13}{16}$ in. Pl.	− 180	.....	+ 2 090	
"	− 690	....	− 980	
24 × ⅞ in. Pl.	− 800	77.48		79.42
"	....	.....	− 2 460	72.37
"	....	.....	+ 3 170	77.41
6 × 6 × $\frac{15}{16}$ in. L.	− 960	78.37	+ 3 400	76.00
"	....	.....	+ 2 060	73.84
6 × 6 × $\frac{15}{16}$ in. L.				
"				

Series 9.—These tests were made to determine the variations in the power required in punching due to the location of the holes and their environment. Both ¾ and ⅞-in holes were punched in varying locations in steel specimens. Holes punched near the sheared edge require from 10% to 20% less work than those punched nearer the center of the plate or angle, the loss being greater with hard steel than with soft. Slight differences in location of the center of the punch do not seem to make great differences, not over at most 1,000 lbs. or so, in the results.

As a rule, plates tested by this method show slightly higher shearing strength than angles or other shapes of the same steel. The writer's experience is that both the tensile and the shearing strength of universal mill-plates increase by from 5% to, in some cases, 10% as the test specimens are selected toward the center of the plates, from the results obtained in test specimens selected near the edge of the plate. This fact is made use of at the mills in the selection of tensile test specimens to fill varying requirements.

AN ADJUSTABLE PISTON VALVE.

The merits of the piston valve for steam distribution are familiar to most engineers, and its defects have also become familiar. It has found its widest use on engines running at very high rotative speed, and engines using very high steam pressure, where its perfect balance avoids trouble from cutting the valve and seat, which is apt to occur under very high pressure steam with any type of slide valve, even when the load on the valve is decreased by using a partially balanced slide valve.

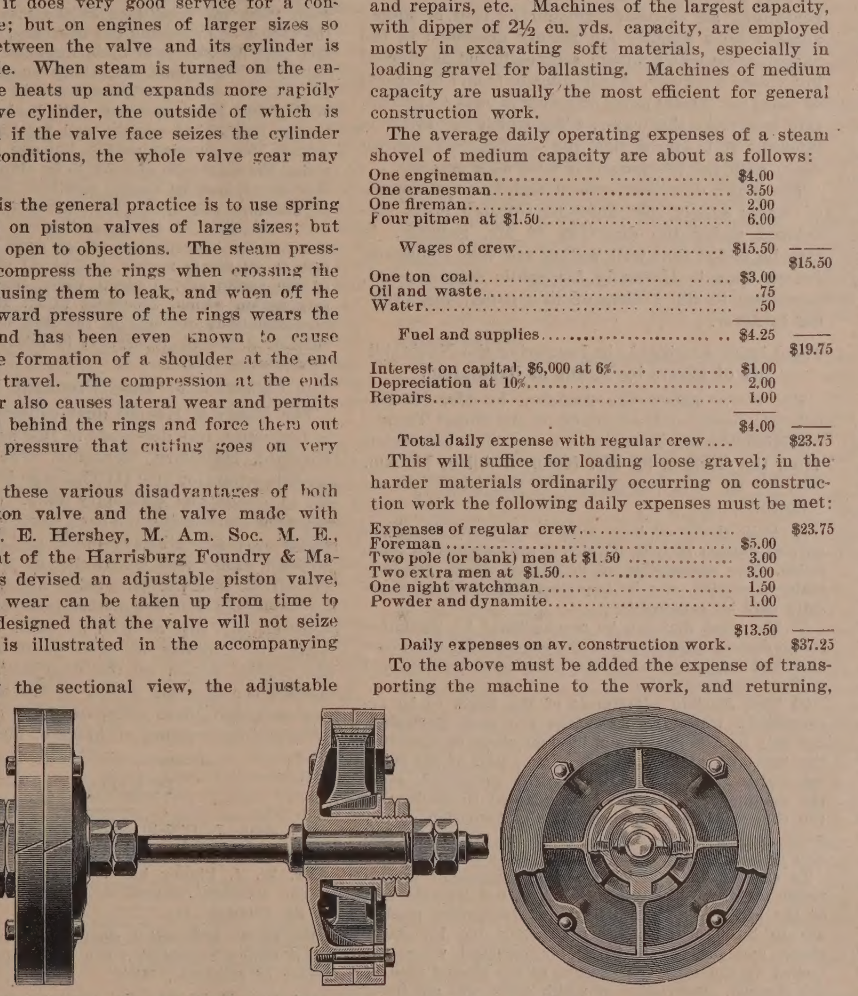
But the fact that the valve is not held to its seat by pressure is the cause of its most serious defect, viz., leakage of steam, and this leakage, while it may be small when the valve is new and well fitted, goes on increasing as the valve wears; in fact, the very blowing of the steam under the valve face probably tends to increase the wear; and it takes but a very minute opening between the valve and the cylinder in which it moves to waste a great deal of steam. On small sizes of engines running at very high speed, the solid chilled piston valve working in a hardened shell and ground to fit it does very good service for a considerable time; but on engines of larger sizes so close a fit between the valve and its cylinder is not practicable. When steam is turned on the engine the valve heats up and expands more rapidly than the valve cylinder, the outside of which is still cool; and if the valve face seizes the cylinder under these conditions, the whole valve gear may be wrecked.

To avoid this the general practice is to use spring packing rings on piston valves of large sizes; but these are also open to objections. The steam pressure tends to compress the rings when crossing the ports, thus causing them to leak, and when off the ports the outward pressure of the rings wears the valve seat and has been even known to cause trouble by the formation of a shoulder at the end of the line of travel. The compression at the ends of the cylinder also causes lateral wear and permits steam to pass behind the rings and force them out with such a pressure that cutting goes on very rapidly.

To obviate these various disadvantages of both the solid piston valve and the valve made with rings, Mr. M. E. Hershey, M. Am. Soc. M. E., Superintendent of the Harrisburg Foundry & Machine Co., has devised an adjustable piston valve, on which the wear can be taken up from time to time, and so designed that the valve will not seize its seat. It is illustrated in the accompanying drawing.

As seen by the sectional view, the adjustable rings which form the periphery of the valve have a broad face, giving ample wearing surface. These rings are held in position by through bolts and when adjusted are held fast and are not free to expand and contract like ordinary packing rings. This adjustment is made while the valve is hot, with live steam between the valve disks. To prevent the seizing of the seats by the rings the spider of the valve piston is made of brass, which has a greater coefficient of expansion than iron. The construction is such that as the valve cools the spider contracts more than the parts surrounding it and in so doing releases the packing rings, leaving them free in their grooves. When steam is admitted the spider again expands and the rings are again held with their original adjustment. It will be seen by the drawing that the valve is much lighter in its construction than the ordinary piston valve, and the strain on the valve gear due to inertia at high speed is thus reduced.

Valves of this pattern ranging from 6 ins. to 18 ins. in diameter have been applied to a number of Ide and Ideal engines manufactured by the Harrisburg Foundry & Machine Works, we are informed, with most satisfactory results.



THE HERSHEY ADJUSTABLE PISTON VALVE.

STEAM SHOVELS AND STEAM SHOVEL WORK.*

By E. A. Hermann, M. Am. Soc. C. E.

Part IV.—Cost of Steam Shovel Work.

(Concluded from page 67.)

The cost of steam shovel work varies greatly with the different conditions affecting each piece of work. It depends mainly upon the nature of the material, its location, the capacity and efficiency of the steam shovel, and the supply of empty cars or wagons. The efficiency of a steam shovel is not necessarily proportional to its capacity, but to the amount of work done compared to its cost; and while the amount of work done is generally larger in the machines of larger capacities, this advantage may be more than balanced by the greater cost of operation, including the cost of labor, fuel, supplies and repairs, etc. Machines of the largest capacity, with dipper of 2½ cu. yds. capacity, are employed mostly in excavating soft materials, especially in loading gravel for ballasting. Machines of medium capacity are usually the most efficient for general construction work.

The average daily operating expenses of a steam shovel of medium capacity are about as follows:

One engineman	$4.00	
One cranesman	3.50	
One fireman	2.00	
Four pitmen at $1.50	6.00	
Wages of crew	$15.50	$15.50
One ton coal	$3.00	
Oil and waste	.75	
Water	.50	
Fuel and supplies	$4.25	$19.75
Interest on capital, $6,000 at 6%	$1.00	
Depreciation at 10%	2.00	
Repairs	1.00	
	$4.00	
Total daily expense with regular crew		$23.75

This will suffice for loading loose gravel; in the harder materials ordinarily occurring on construction work the following daily expenses must be met:

Expenses of regular crew		$23.75
Foreman	$5.00	
Two pole (or bank) men at $1.50	3.00	
Two extra men at $1.50	3.00	
One night watchman	1.50	
Powder and dynamite	1.00	
	$13.50	
Daily expenses on av. construction work.		$37.25

To the above must be added the expense of transporting the machine to the work, and returning, after its completion, raising the crane on arrival at and lowering the same on the return from the work, placing the machine in position when beginning work; picks, shovels, axes, mattocks, bars and other small tools, wooden blocking, blacksmith shop and supply sheds, powder vault, laying and maintaining tracks, or grading roads or driveways, and a number of minor wants, varying greatly in cost, but averaging about $600, or about $2.75 per day for a season's work of eight months, making the total expense of operating a steam shovel on average construction work $40 per day.

The cost of excavating and loading per cubic yard varies greatly; it depends mostly upon the nature of the material and very largely upon the constancy of keeping the steam shovel at work by an ample supply of empty cars or wagons. The average cost of loading different materials is about as follows:

Sand and loose gravel	3	cts. per cu. yd.
Loam	3½	"
Dry clay	4	"
Damp clay	6	"
Stiff blue clay	8	"
Cemented gravel, hardpan, mixed clay and bowlders, loose rock and other materials loosened by explosives	10 to 16	"

The cost of hauling is also a variable item; it depends mostly upon the length of the haul, and on railways very largely upon the delays met with in going to and from the dumping place. On construction work it is seldom less than 3 cts. per cu. yd., and sometimes reaches 10 cts. On railways it is not often below 4 cts. for hauls up to 10 miles in length, and may reach 50 cts. or more for hauls of 75 miles or farther.

Dumping is a very small item where small dump cars are used on construction work, and does not exceed ½ ct. per cu. yd. When wagons are used it will average about 1½ cts. On railways the cost of unloading with the plow varies somewhat, depending upon the kind of material; it averages about ½ ct. per cu. yd. Unloading by hand averages 6 cts.

On railway work, where the spreader is used, the average cost of leveling the material for widening embankments is only 0.1 ct. per cu. yd.; spreading it by hand will range from 5 to 20 cts. per cu. yd. for widths of 5 to 15 ft. from the unloading track.

The total cost per cu. yd. of excavating and loading, hauling and dumping different kinds of materials with the most usual length of haul averages about as follows:

	Loading. Cts.	Hauling, Cts.	Dumping. Ct.	Total-Cts.
Sand and loose gravel	3	4 to 10	½	7½ to 13½
Loam	3½	"	"	8 to 14
Dry clay	4	"	"	8½ to 14½
Damp clay	6	"	"	10½ to 16½
Stiff blue clay	8	"	"	12½ to 18½
Cemented gravel, hardpan, etc., materials loosened by explosives	10 to 16	"	"	14½ to 26½

The steam shovel will do the work of 60 to 120 men, saving from 5 to 25 cts. per cu. yd. of material excavated and loaded. The gain is proportionally much greater in the harder, and particularly in the more tenacious materials. The machine is not adapted to small jobs, and is seldom worked in cuts of less than 8 ft. in depth; nor is it cheaper than hand and team labor on such small jobs, but on nearly all large work it is much cheaper and faster; and last, though not least, its use largely reduces the number of laborers required, and hence the probability of strikes and other labor troubles.

ABSTRACTS OF PAPERS PRESENTED AT THE INTERNATIONAL ENGINEERING CONGRESS.

The International Engineering Congress held in Chicago this week under the direction of the several principal engineering societies of the United States has brought out a large number of very interesting papers both from the members of the American societies and from the foreign engineers invited to participate in the proceedings. Several of the most important of these papers will be reprinted or abstracted nearly in full in early issues of this journal and the others abstracted more or less briefly. The following are abstracts of several of those read before the department of civil engineering:

Recent Experience on the U. S. Coast and Geodetic Survey in the Use of Long Steel Tapes for Measuring Base Lines.

In this paper Mr. R. S. Woodward gave the results of a series of experiments made by him in the interest of the United States Coast Geodetic Survey to determine the practicability of using long steel tapes for measuring lines of precision. Results of experiments made with two tapes at Washington, D. C., and observations on the measurement of two actual base lines, 5,500 m. and 3,870.5 m. long, respectively, using 100 m. tapes, are given in detail. The conclusion arrived at was that for such temperatures as are likely to be had in the use of these tapes the probable errors of their absolute lengths will not exceed + 0.06 mm., or one 200,000th part of their lengths.

Terrestrial Magnetism in North America.

This paper, by Mr. Charles A. Schott, Assistant U. S. Coast and Geodetic Survey, was wholly historical in character. It gave an outline history of the various discoveries and accessions to the knowledge of terrestrial magnetism from the time of Columbus to the present time, and touched briefly upon the laws so far recognized, with more or less certainty, as governing the changes in the direction and intensity of the earth's magnetic force during that time,

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Carbon and Its Uses in Electrical Engineering.

In this paper Mr. C. M. Barber stated that a slight idea of the growing magnitude of the use of carbon for electrical purposes may be gained from the fact that it claims an investment of $1,500,000 in the United States. Its principal use is, of course, for arc lamps, about 200,000,000 carbon pencils being used per year for this purpose alone. Among other important uses for carbon are for the positive poles of primary open circuit batteries and for crucibles. Recently it is being used considerably for brushes for dynamos and motors in the place of copper. Its chief advantage here is that it reduces the cutting of the commutators and the sparking to practically nothing. Increasing use is also being made of the carbon flame in spectroscopy. It affords one of the best subjects for spectrum analysis, and is, therefore, of great value for this purpose, and by its use the field of the spectroscope has been greatly enlarged.

The Improvement of the Harbors of the South Atlantic Coast of the United States.

This bulky paper, by Mr. Wm. M. Black, Corps of Engineers U. S. A., gave very full descriptions of the methods adopted in improving several of the more important harbors along the coast of the South Atlantic states. Most of the matter given is ancient history to American engineers, and its chief value lies in the fact that it has been brought into a compact form for easy reference.

History of the Conversion of the River Clyde Into a Navigable Waterway and of the Progress of Glasgow Harbor From Its Commencement to the Present Day.

This paper was prepared by Mr. Jas. Deas, Engineer Clyde Navigation, who treated: (1) Of the history of the improvement of the river; (2) of the progress of the harbor; (3) of the rise and progress of shipbuilding on the river and its tributaries, and (4) gave a short description of other harbors on the river besides Glasgow. The first recorded attempt to improve the Clyde was made in 1566, but nothing of permanent value seems to have been done unil 1768, the river meanwhile becoming shallower. In that year a civil engineer of Chester, named John Galborne, began the work of contracting the river by constructing rubble jetties and of deepening it by the removal of sand and gravel by means of ploughing, harrowing and dredging. When this work was begun only herring boats and similar craft could navigate the river. At present, Mr. Deas states, the depth of the water in the harbor of Glasgow and in the river is from 27 to 29 ft. at high water and about 2 ft. higher at spring tides. A very large part of the improvement of the river has been made possible by the use of steam dredges, but diamond drills also played a very important part, as is described in detail in the paper. The depening of the river has necessitated much dock reconstruction and strengthening, some of which Mr. Deas describes.

The total exports from Glasgow for the year ending June 30, 1892, amounted to 2,594,213 gross tons, and the total imports to 2,302,604 gross tons.

Description of the Lower Weser and Its Improvement.

A description of the improvement of that portion of the River Weser, between Bremen and Bremerhaven, Germany, a section of 42¾ miles, known as the Lower Weser, was given in this paper by Mr. L. Franzius, the engineer in charge of the work. The object of the improvement was to make a uniform and deep channel and to maintain the created conditions by increasing and regulating the current power. The necessary dimensions of the channel being determined, it was marked out by constructing two parallel guide dikes. These dikes were made of mattresses of brush placed on top of each other until the necessary height of dike was attained. Each mattress was narrower than the one below it, thus giving the dike a slope on both sides. After the completion of the dikes, the channel between them was dredged out, the dredged material being deposited on the outer sides of the dikes. The cost of dredging was 6.8 cts. per cubic meter, and the total cost of the completed dike was from $1.41 to $1.64 per cubic meter.

Experiences Had During the Last 25 Years with Water-Works Having an Underground Source of Supply.

This paper was prepared by Mr. B. Salbach, Government Engineer, Dresden, Saxony, and translated by Mr. Clemens Herschel, M. Am. Soc. C. E. Some of the most interesting parts of the paper relate to methods employed to rid water of an excess of iron. At Halle, in 1868, water containing a troublesome amount of iron was passed through gravel resting on a sieve, from which it dropped to a sand filter. This resulted in an escape of sulphureted hydrogen and a great improvement in the water. Later, the same process was tried at Charlottenburg for the same purpose. At Norderney, a watering place on the North Sea, water containing an excessive amount of iron is simply aerated (in a manner not plainly described in the paper), after which simple sedimentation is effected in a closed reservoir. At Groningen, from 1 to 2 parts of alum per 20,000 parts of water is used to precipitate iron from the water, after which the latter is filtered. It is stated that the solid matter thrown down with the precipitate is used as a manure.

The paper describes several underground sources of water supply, for different German cities, developed under the direction of Mr. Salbach. It may be added that well waters are very commonly drawn upon in Germany for public supplies, and, according to the author of this paper, are growing in favor.

The Limits Attainable in Improving the Navigability of Rivers by Means of Regulation.

The above paper was prepared by Mr. H. Engels, Professor of Hydraulics, in the Royal Technical High School, Dresden, Saxony, and translated from the German by Mr. Kenneth Allen, M. Am. Soc. C. E. The conclusions of the paper are as follows:

> (1) Only rivers or long reaches of rivers in which natural erosion is fully developed are adapted to regulation. The navigability of unfinished rivers, yet in a state of erosion, can be improved with permanent results only by canalization.
>
> (2) The most that can be accomplished by regulation is the desired adjustment of the slope of the low-water line, and this only on reaches of uniform regimen and uniform characteristics.
>
> (3) This feasible adjustment of the slope, to be accomplished when the conditions are most favorable, can only be established and brought about by constructive measures after formation of that part of the channel which rises above low water is completed; after the conditions of the bed have adapted themselves to the change of energy caused by the formation of the mean high water bed—in other words, after the erosion caused by this formation has come to rest.
>
> To secure the establishment and permanent preservation of the adjustment of slope, the irregularities of the bed in the longitudinal and transverse profiles are to be adjusted after reinforcing the low-water shore, and the bed is to be strengthened where attacked by the water on account of the ground plan of the channel. Restriction of width alone will not bring about that degree of navigability which may be attained.
>
> The maximum depth of water to be maintained during low water is then determined by equations (1), (2) and (3), as follows:
>
> $$Q = wdv, \qquad (1)$$
>
> $$v = K\sqrt{di}, \qquad (2)$$
>
> in which d and v (velocity) are unknown, Q (volume of water) is to be determined by measurement, w is the natural low water width of the surface in the required mean water bed, to be measured in the apex of the bend; i is the adjusted rate of fall attainable. It suffices to determine k approximately from the equation
>
> $$K = \frac{v}{\sqrt{di}},$$
>
> in which we give a value to the right-hand member to be established by measurement in the low water channel existing in good natural reaches.
>
> From (1) and (2) we obtain the equation
>
> $$d = \left(\frac{Q}{W K \sqrt{i}}\right)^{2/3} \qquad (3)$$
>
> This equation shows that d decreases in the pools, because the slope i increases while w is unchanged; further, that d increases on the summits of the passages as a decrease of i takes place, in consequence of the uniform establishment of the natural low water width of the apex of the bend, and therefore a better concentration of the water, and also from a decrease **of w.**

The following are abstracts of some of the papers presented before the Mechanical Engineering Section of the Congress. Abstracts and full reprints of the most important of the others will be given in future issues:

Contribution to the Theory of the Steam Engine.

This paper, by Prof. V. Dwelshauvers-Dery, of Liege, Belgium, is an attempt to establish a general formula giving the maximum of work to be obtained from heat engines for a given expense of heat or steam, whatever may be the type of machine employed. The author states his theme thus:

> For hydraulic motors it has been found convenient to make certain hypotheses plausible enough, on which generic theories could be based, in order to deduce from them the conditions of the maximum effect or the means of increasing the efficiency. In spite of the fact that the results of these formulas have to be corrected by coefficients sometimes enormous, furnished by practice, they are generally held as of real use. Why should it be otherwise with heat engines? There can be established equally well for the different heat engines, not generic theories, but one general formula giving the maximum of work to be obtained for a given expense of heat or steam, whatever may be the type of machine employed. This formula, in a different way from that of the perfect cycle, would take account of the imperfections of the cycle which are common to all steam motors, but would not take account of the action of the metal walls, because it is this very action which, according to M. Hirn, forms the insurmountable obstacle in the way of the establishment of a generic theory. It is this topic which will be discussed here.

The Collection of Dust Produced in Workshops.

The Nagel & Kaemp dust collector, much used in Germany, was described in this paper by Mr. R. Kohfahl, Hamburg, Germany. The claims made for this separator are: (1) The cage is fixed immovably to a solid and stationary plate. (2) The instrument for introducing the back draft of air rests and slides on this stationary plate, and, therefore, can be kept easily and constantly in airtight contact. (3) All the filtering cells being arranged vertically, the dust can fall down unstopped from any point between the sills as well as from the outside of them. (4) Gravity at each point diminishes the obstructing action of the dust-laden air, but increases the cleaning action of the back draft. It is stated that these collectors have proved equally efficient for removing all kinds of dust.

PERSONALS.

Mr. John J. O'Neill has resigned his position as Township Engineer of East Orange, N. J.

Mr. W. J. Finney has been appointed Roadmaster of the Missouri, Kansas & Eastern Ry., with offices at St. Charles, Mo.

Mr. E. W. Muenscher, Chief Engineer of the Manistee & Grand Rapids Ry., has been appointed City Engineer of Manistee, Mich.

Col. Geo. E. Waring, Jr., sanitary engineer, of Newport, R. I., was married July 20 at Dellwood, Minn., to Mrs. Louise Yates, of New Orleans, La.

Mr. W. J. Wilgus has been appointed Assistant Chief Engineer of the Rome, Watertown & Ogdensburg R. R., with headquarters at Watertown, N. Y.

Mr. James E. Palmer has been appointed General Superintendent of the Peoria & Pekin Union Ry., vice C. E. Schaff, who has resigned to accept other service.

Mr. Charles P. Deane, of the Deane Steam Pump Co., of Holyoke, Mass., has received the honorary degree of Master of Arts from Brown University, from which he graduated in 1867.

Mr. M. J. Caples has been appointed Assistant Engineer of the Clinch Valley & Pocahontas divisions of the Norfolk & Western R. R., with headquarters at Bluefield, W. Va., vice A. P. Miller, resigned.

Mr. A. S. Cooper, City Engineer of West Duluth, Minn., has resigned and the City Council has tendered him a written expression of the satisfaction felt with his work. Mr. W. H. Cruikshank has been promoted to the position of City Engineer.

Mr. H. H. Sessions, Manager of the Pullman Palace Car Co.'s works, has been appointed Chief Mechanical Engineer of the company, with headquarters in Chicago. Mr. Harvey Middleton, Superintendent of Construction, has been appointed to succeed Mr. Sessions as Manager of the Pullman works. Mr. A. M. Parent has been appointed Assistant Manager of the works.

Mr. W. Kummel, engineer of the water-works of Altona, Germany, died in Chicago, July 9. Mr. Kummel prepared a paper for the International Engineering Congress, entitled "Some Questions Concerning the Filtration of Water," and was commissioned by the German government to examine American water-works.

Mr. Albert F. Noyes, whose resignation as City Engineer at Newton, Mass., was noted last week, will remain with the city until the contracts which need his supervision are completed. Mr. Noyes has been in the service of the city for more than 17 years, and has been City Engineer 15 years. He has had charge of the construction of the new high-service water system and the city sewer system. He was also the originator of a novel system of waterway improvements, and has designed Newton's park and boulevard system. He leaves the city to accept an offer from the State Board of Health. The aldermen of Newton have adopted resolutions expressing regret at his resignation, and offering to him the thanks of the city for his long and faithful service. Mr. Noyes will probably not enter on his new duties until October.

Mr. Wm. Scherzer, M. Am. Soc. C. E., died very suddenly at Chicago on July 20, of typhoid fever. Mr. Scherzer was a native of Peru, Ill., and was about 35 years of age. He graduated from the Zurich Polytechnic Institute, and during his professional life was engaged chiefly in bridge and structural work. He was located for some years in Pittsburg, first with the bridge department of the Pennsylvania R. R., and later with the Keystone Bridge Co. Afterward he was associated with Mr. C. L. Strobel in the Chicago department of Carnegie, Phipps & Co. He has recently been engaged as consulting engineer with the Metropolitan Elevated R. R., of Chicago,, and at the time of his death had just completed designs for a novel folding bridge to carry the line of that road across the Chicago River.

Mr. John Stephenson, the originator and well known manufacturer of the American omnibus and street car, died at New Rochelle, N. Y., on July 31. Mr. Stephenson was born in County Armagh, Ireland, on July 4, 1809, but came to the United States with his parents in 1811, and settled in New York. He was educated at the Wesleyan Seminary in this city, and prepared for a mercantile life, but his fondness for mechanics led him to commence business on his own account in repairing the stages of the line then running from Bleecker St. to Wall St. On May 1, 1831, he designed and built the first vehicle in New York, known as the omnibus. His place was burned out in 1832, but he opened again the next year and built a car of an entirely original design for the New York & Harlem Street Car Co., chartered in 1831. He patented this car, and was soon busily engaged in building them for other lines, and thus founded the establishment yet in active existence, which has supplied street cars for nearly every American city and the chief cities of Europe, for Australia, Africa, Japan, etc.

NEW PUBLICATIONS.

ASSOCIATION OF DOMINION LAND SURVEYS.—Report of Proceedings of the Ninth and Tenth Annual Meeting, held at Ottawa, in February, 1892 and 1893. Secy., J. I. Dufresne, Ottawa. 8vo; pp. 85.

In addition to reports and proceedings there are the following papers: "Irrigation Legislation; Its Primary Principles," Wm. Pearce; "The Measurement of Distances to the Stars," W. F. King; "Latitude by Elongation;" "Exploratory Surveys," Wm. Ogilvie; "Are the Great Lakes Retaining Their Ancient Level?" J. G. Boulton; "Geographical Nomenclature," A. H. Whitcher; "Arithmometer," J. I. Dufresne; "Maps and Map Making," "Several Processes by Which Surveyors Can Reproduce Their Views."

TRADE PUBLICATIONS.

WORTHINGTON PUMPING ENGINES, STEAM PUMPS AND HYDRAULIC MACHINERY.—General Catalogue for July 1, 1893. 12mo; 104 pp.

The latest issue of this excellent pump catalogue, very fully illustrated and with detailed tables of dimensions and capacities.

BOILER REVIEW.—Hogan Boiler Co., Middletown, N. Y. 8vo; pp. 64; illustrated.

The greater part of this publication is devoted to a discussion on circulation in boilers.

ELECTRIC MOTORS, manufactured by the Siemens & Halske Electric Co., of America. Chicago, Ill. Trade pamphlet. 25 pp.

An illustrated description of the various electric motors made by this company and their application to many tools and purposes. Among the latter is a sinking pump for shaft work very compactly arranged in a wrought iron frame.

PUMPS.—Gould's Mfg. Co., Seneca Falls, N. Y. 16mo; pp. 14; illustrated.

This is a souvenir pamphlet with views and particulars of the company's goods which are exhibited in actual operation at the World's Columbian Exposition.

SOCIETY PROCEEDINGS.

GERMAN ENGINEERING SOCIETY.—A "Fest Commers," which, being freely translated, means meeting to have a jolly good time, according to German customs, was given by the visiting German engineers in honor of the Associated American engineers at the Germania Club, in Chicago, on Tuesday evening, July 25. The company numbered over 200, and was entertained with speeches, toasts, music and plenty of supplies for the inner man. The program included nearly a dozen songs specially written for the occasion by the visiting German engineers, and they were sung with genuine German student fervor by the assembled company.

NEW ENGLAND ROADMASTERS' ASSOCIATION.—The eleventh annual convention of the Association will be held at the American House, Boston, Mass., Aug. 16 and 17. The convention will open at 1:30 p. m., Aug. 16. Committees selected by the Executive Committee will submit reports on the following subjects:

(1) Best Method of Relaying Rail in Main Track. Details to be observed for insurance of safety and economy; proper handling of rail before placing in track and care of same immediately after it is laid in track. (2) Comparative Merits of Spring Rail and Stiff Rail Frogs; when each kind is properly and thoroughly made. (3) Care of Station Grounds; under whose direction should work on same be done and responsibility for appearance of the grounds rest? (4) Importance of Railroads Owning Good Gravel Pits; economy of usng good ballast in roadbed maintenance; best and most economical method of loading and unloading ballast.

Mr. P. H. Dudley has accepted an invitation from the Executive Committee to be present, and will read a paper on "Steel Rails; Their Manufacture and Service," treating briefly of all the steps in the process from the pig iron to the finished rail in the track. The afternoon of the second day will probably be devoted to social recreation. G. L. R. French, Secretary.

ENGINEERING CONGRESS.—The congress of engineering in connection with the World's Columbian Exposition opened on Monday, July 31, the meeting being held in the Art Palace on the Lake Front, near Adams St. The congress commenced at 10:15 a. m., Mr. C. C. Barney, President of the World's Congress Auxiliary, in the chair, and a number of leading American and foreign engineers on the platform. There was a large attendance of engineers of all branches of the profession, together with a number of ladies. Mr. Bonney, in his address of welcome, noted the fact that never before had there been such a collection of eminent names in the profession or such an important collection of important papers. Engineering, he said, is now conceded to be one of the great professions, and institutions of learning must provide for education for this as for the older recognized professions. His speech was brief, and at its close he introduced Mr. O. Chanute, chairman of the executive committee of engineering societies, who has done so much to perfect the arrangements for this congress and for the general comfort of visiting engineers. In a few interesting remarks he referred to the international character of the gathering, which character was evident to the most casual observer. Short address were then made by several eminent engineers, the brevity of the remarks and promptness of proceedings generally being favorably commented upon. Sir Benjamin Baker, representing Great Britain and the Institution of Civil Engineers, delivered a greeting from the Smeatonian Society of Engineers, the oldest engineering society in the world, which has had but about 40 members, all of whom, however, have been men of world-wide celebrity. Sir Benjamin Baker was succeeded by other distinguished foreign engineers, as follows: Baron Quinette de Richermont, of France; C. O. Gleim, of Germany; N. Koestler, of Austria; A. Nyborg, of Russia; and Chev. Capacci, of Italy. American engineers were then represented by brief addresses from Mr. W. Metcalf, for the civil engineers; Mr. E. B. Coxe, for the mechanical engineers; Mr. H. M. Howe, for the mining engineers; Mr. I. O. Baker, for the engineering educators; a representative of Major Comly, U. S. A., for the military engineers; and Commodore Melville, U. S. N., for the naval engineers. At the conclusion of these introductory exercises the various divisions of the congress assembled in the smaller rooms for the reading and discussion of their papers. Abstracts of papers presented we shall give in separate articles from the reports of proceedings.

In Division A, Civil Engineering, the following papers were read in very brief abstract: "Navigation Works Executed in France from 1876 to 1891," by M. F. Guillain; "Common Roads, Railway and River Communication in Portugal," F. A. Pimental; "The Rearrangement of the Railway Terminal System at Altona (Germany), with Special Reference to the Avoidance of Grade Crossings," R. Caesar. There was no discussion on any of these papers, but Mr. Gleim pointed out that the translator of the latter paper had made the mistake of using the term "street railway" for "stadtbahn," although this word really stands for an ordinary railway, but for city traffic instead of ordinary through or country traffic. The meeting then adjourned.

In Divisions C and D, Mining and Metallurgical Engineering, the following papers were read by title or in brief abstract: "Mining Schools," Prof. S. B. Christy; "Mining and Mineral Statistics," C. L. Foster; "Genesis of Ore Deposits," F. Posepuy; "Geological Distribution of the Useful Metals in the United States," S. F. Emmons; "Lead and Zinc Deposits of the Mississippi Valley," W. P. Jenney; "Mineral Deposits of Southwest Wisconsin," W. P. Blake; "Origin of the Gold-Bearing Quartz of the Bendigo Reefs," T. A. Rickard; "A Remarkable Deposit of Ores of Wolfram in the United States," A. Gurlt.

In Division E, Engineering Education, the principal subject on the program was the "Present State of Collegiate Engineering Education," under which head different papers were listed, but the only one presented was that by Prof. S. B. Christy on "Mining Engineering," which was discussed by Professor Monroe, of the Columbia School of Mines, and Professor Swain, of the Massachusetts Institute of Technology. Professor Monroe referred to the prejudice in favor of the practical miner in preference to the graduates of schools for positions of responsibility in mines, and also referred to the summer schools of mines, which give the students practical work in the mines, and therefore teach them what can never be learned in college. After this discussion some time was wasted in discussing whether or no to follow the printed program.

The meeting adjourned in time for those present to get lunch before taking the whaleback steamer "Christopher Columbus" for a trip, by invitation, to the World's Columbian Exposition. At the time of assembling, however, it was announced that the lake was so rough that steamers could not make a landing at the Exposition pier, and the party had therefore to go down by train.

COMING TECHNICAL MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 31 to Aug. 5. Chicago, Ill. Secy., R. W. Raymond, 13 Burling Slip, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
July 31 to Aug. 5. Annual Convention at Chicago. Secy., F. Collingwood, 127 East 23d St., New York.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
July 31 to Aug. 5. Annual Convention at Chicago. Secy., F. R. Hutton, 12 W. 31st St., New York.

DEUTSCH-AMERIKAN TECHNIKER VERBAND.
Aug. 1 to 6. Annual meeting at Chicago. Secy., A. Nurick, Pittsburg, Pa.

WESTERN SOCIETY OF ENGINEERS.
Aug. 2. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF ST. LOUIS.
Aug. 2. Secy., Arthur Thacher, Odd Fellows' Building.

ENGINEERS' CLUB OF MINNEAPOLIS.
Aug. 3. Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Aug. 4. Secy., E. K. Smoot, 803 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Aug. 4. Secy., O. Von Geldern, 719 Market St., San Francisco.

SWEDISH ENGINEERS' CLUB.
Aug. 5. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

NORTHWEST RAILROAD CLUB.
Aug. 8. Secy., W. D. Crosman. Ryan Hotel, St. Paul.

NORTHWESTERN SOCIETY OF ENGINEERS.
Aug. 8. Secy., D. W. McMorris, Burke Block, Seattle, Wash.

DENVER SOCIETY OF CIVIL ENGINEERS.
Aug. 8. Secy., F. E. King, Jacobson Block.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Aug. 9. Wichita, Kan.

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Aug. 10. Secy., F. W. Mowbray, Norton Building.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Aug. 11. Secy., D. W. Meeker, St. Paul.

MONTANA SOCIETY OF CIVIL ENGINEERS.
Aug. 12. Secy., G. O. Foss, Helena.

ENGINEERS' CLUB OF KANSAS CITY.
Aug. 14. Secy., Waterman Stone, Baird Building.

WISCONSIN POLYTECHNIC SOCIETY.
Aug. 14. Secy., M. F. Schinke, City Hall.

COLUMBIAN ENGINEERING SOCIETY.
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Aug. 18. 201 Washington Building.

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Sept. 5. Secy., W. Halliburton.

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Sept. 20. Secy., L. V. Carmalt, Roanoke, Va.

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Sept. 20. Secy., S. E. Tinkham, 36 Broomfield St.

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ENGINEERS' CLUB OF CINCINNATI.
Sept. 21. Secy., J. F. Wilson, 24 W. 4th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB
Sept. 21. Secy., S. A. Charpiot, Macon, Ga.

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Sept. 22. Secy., C. H. McLeod, Montreal, P. Q.

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Sept. 27. Secy., S. W. Spear, Buffalo, N. Y.

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Oct. 2. Secy., C. L. Annan, City Engineer's Office.

ENGINEERS' CLUB OF PHILADELPHIA.
Oct. 7. Secy., L. F. Rondinella, 1122 Girard St.

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AND

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The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering Headquarters, at Chicago, are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains, and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

◆

A correspondent calls our attention to the fact that the heading of our item in the last issue—"The Break in the Austin Dam, Texas," was a misnomer, as our text shows that the break was not in the dam at all, but in the canal and headgate work outside of the dam. In other words, the dam itself is intact. We accept the amendment and do so the more willingly as the dam itself was lately the subject of some very personal remarks between Mr. Frizell, who is mainly responsible for the design, and the present consulting engineer, Mr. Fanning. We have no desire to reopen this controversy, but believe it is only due to Mr. Frizell to say in plainer terms than those of our late item that the failure at this work was not in the dam, but in the canal and headgates, against which, as we understand the controversy, he protested.

◆

For the [illegible]rth time in its history the property now controlled by the New York, Lake Erie & Western R. R. Co. was last week placed in the hands of receivers. To those who have followed the finances of the company this action causes little surprise, at it is well known that for a long time the company has been loaded with a burdensome floating debt of between $6,000,000 and $7,000,000, which has menaced its welfare and financial standing. While a company may easily carry a floating debt as great as this in times of easy credit, it must go to the wall when, as is now the case, the market for time loans is closed to borrowers with the best of security, and this is exactly what the Erie has done and only just escaped doing in 1884. All things considered, the management has taken the wisest step both for the owners and the creditors, as it prevents the control of the company's obligations from passing into the hands of speculators who might use them to the injury of the property. The worst effect of the action is likely to be the raising of doubts as to the stability of other railway property. It must be remembered, however, that the financial career of the Erie has been an exceptional one. Until the present management took possession, the property was the chosen field of rascally speculators at first, and an incompetent and extravagant management later, who placed on it a load of bonded indebtedness under which it has been staggering ever since. Its downfall does not then reflect a bankrupt condition of railway property in the United States nor any inherent weakness in the general railway system. It is true that other companies have been heavy borrowers, but these have either placed their loans in notes which will not mature until the present strain is over, or else have used their foreign credit. Other companies yet possess such an outlook and resources as to assure them aid from capitalists personally concerned in their solvency. Altogether the failure of the Erie has less general significance than almost any similar event which could have occurred.

◆

Is riveting done by a hydraulic riveter any better than that done by a steam or pneumatic riveter? We are led to propound this question by hearing the manager of a locomotive building establishment having a very high reputation for the quality of its work declare emphatically that the work done by hydraulic riveters was much superior to that done by the other two machines. He gave as reasons for this opinion that with a wide gap riveter there is of necessity considerable spring to the jaws when pressure is turned on. With the steam or air riveters the force back of the piston is elastic and the tendency of the plates to spring apart and the yielding of the frame of the riveter may result in a minute opening of the plates. In other words, conceive the work done by the riveter to be the compression of a spring. A steam or air riveter would strike a blow upon the spring, would compress it a little beyond the point where the resistance of the spring equaled the pressure of the air or steam, and then would spring back slightly. The hydraulic riveter, on the other hand, keeps all it gets. It is a steady pressure and no reaction is possible.

A second reason, and one which appeals with more force than the first, is that the hydraulic riveter cannot be pulled off the work as quickly as the steam or air machines, and the rivet has more time to cool and gain strength sufficient to hold the plates in position before the pressure is released. Even with the hydraulic riveter it is claimed that men are apt to release the pressure too soon, and thus permit the plates to open; and the rapidity with which an expert gang can drive rivets with a pneumatic machine is well known.

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Are the reasons valid, and is it a fact that hydraulic riveted work is stronger and tighter than pneumatic or steam riveted? Or, to put the question in another form, is the riveting done in the first-class bridge shops any worse or better than that done in the best boiler shops by hydraulic machines? Of course, it must be conceded at once that so high grade work in the riveting is not called for in structural work as in boiler work. It is better by far to do rapid work and compensate for any loss in strength by using a little heavier metal and larger rivets; and in doing rapid work, an occasional rivet head is likely to be off center.

But, notwithstanding this, there is some reason to believe that the work of the bridge shops at the present day need not fear comparison with that of the boiler makers. For a sample of bridge builder's work we suggest to our readers who are visiting the Columbian Exposition, that they examine the section of the top chord of a 440-ft. bridge span in the exhibit of the New Jersey Steel & Iron Co., and notice the fit of the rivets in their holes. As a general rule, nowadays, bridge engineers are specifying that rivet holes shall either be drilled or shall be punched small and reamed after the pieces are assembled, and the rivet must fit its hole within 1-32 in. In some cases pains is taken to countersink the sharp corner of the hole under the rivet head. The result is a junction between the rivet and the plates so close that the dividing line can scarcely be discovered.

Now, contrast with this the fact that very common practice among boiler makers of punching holes without reaming and using the driftpin to correct the inevitable inaccuracies. Even the warm advocate of hydraulic work, to whom we alluded above, confessed he was punching all his plates and doing no reaming; and he defended the practice by saying that he allowed a large enough margin of strength in plates and seams to make punching permissible. We record these facts without prejudice in favor of either side, and if any of our readers have further information of value bearing on the question, we shall be pleased to give space to their communications.

WATER PURIFICATION IN AMERICA.

The intimate relation between drinking water and disease has been very forcibly brought to the attention of the American public in the last two or three years by the epidemics of typhoid fever at Chicago, Lowell and Lawrence, St. Louis and other localities known to have sewage-polluted water supplies, and by the comparative immunity from the disease of Boston, New York and other cities, whose water supplies are known to have relatively little sewage contamination. The cholera danger of 1892, widely disseminated the generally accepted belief that drinking water is the main carrier of cholera and typhoid fever and naturally increased in a marked degree the newly awakened interest in methods of securing pure water supplies.

Under such circumstances the natural inquiry is: What is the present status of water purification in America and to what municipalities may one turn for successful examples of water purification?

To answer this double question we begin in this number a series of articles entitled "Water Purification in America," in which some of the more recent, at least, of American water purification plants will be described in detail and the general principles involved will be discussed.

As some definition of the term water purification seems desirable, it may be stated in a rather broad way, for present purposes, that it includes all attempts to improve the quality of a water supply, and more especially positive attempts in the way of actual purification of a supply of unsatisfactory character, rather than what may be termed negative purification, or the prevention of pollution; also that the articles will be confined either wholly or more particularly to the sanitary side of the water supplies of cities, with purification effected from central stations, or in bulk, although the private water supplies of manufacturing plants, of institutions and households may, perhaps, be considered to some extent.

The simple settlement of turbid waters, the storage of surface waters and the natural filtration which, to a greater or less extent, all underground waters receive, as well as artificial filtration, aeration and chemical treatment, single or combined, may properly be classed among the water purification processes of which advantage is sometimes taken or which have been or may be attempted.

There are numerous instances where the quality of water has been improved by sedimentation and storage, but sedimentation alone is seldom wholly satisfactory, and storage has generally been employed to secure quantity and not quality of water, any degree of purification secured being incidental, in most cases, to storage pure and simple. Probably St. Louis, Mo., has employed sedimentation on a larger scale than any other American city, while New York, Boston, Baltimore, San Francisco and hundreds of other cities have derived such

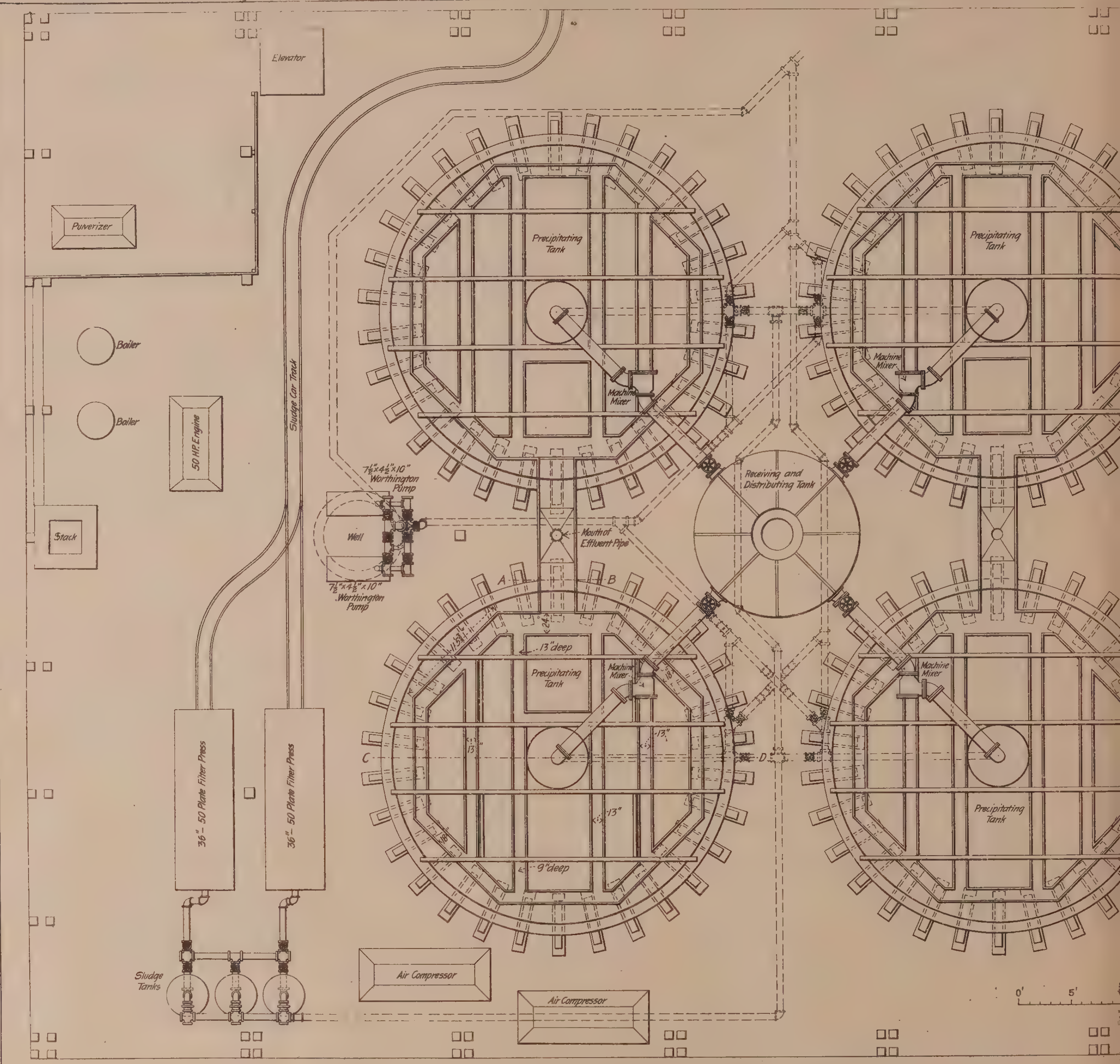


FIG. 1. PLAN OF SEWAGE PURIFICATION PLANT.

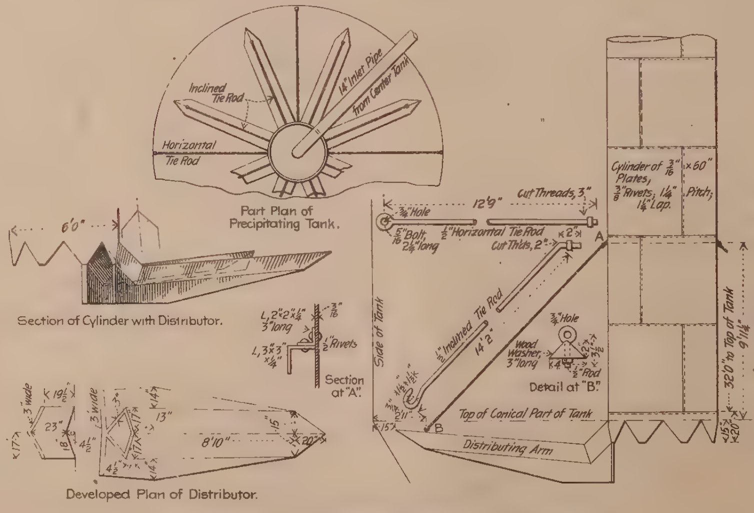


FIG. 6. CENTRAL CYLINDER AND DISTRIBUTING ARMS.

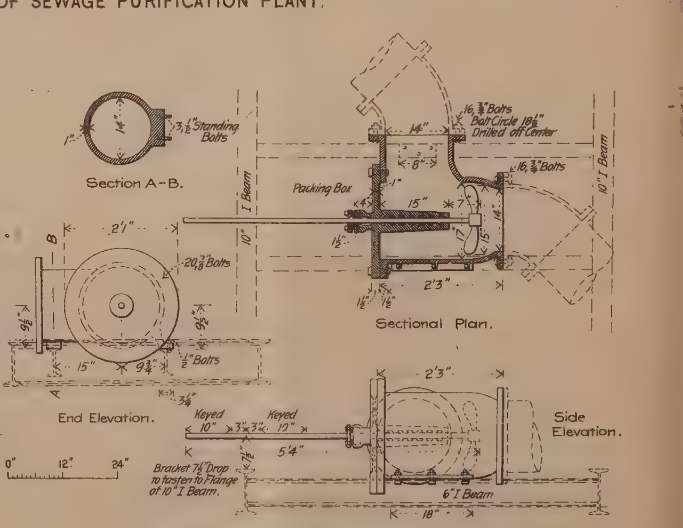


FIG. 4. CHEMICAL MIXER.

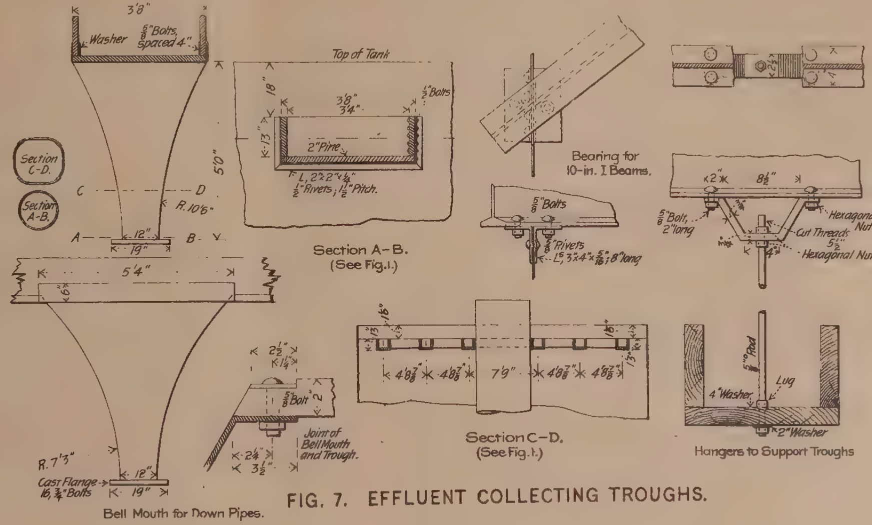


FIG. 7. EFFLUENT COLLECTING TROUGHS.

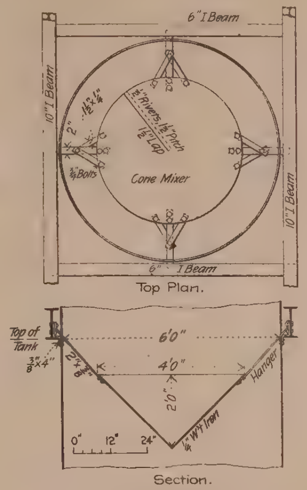


FIG. 5. CONE MIXER.

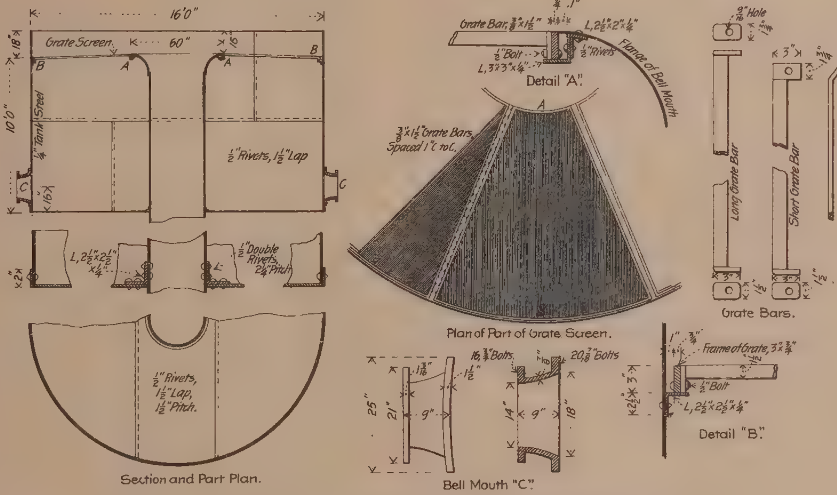


FIG. 3. DETAILS OF RECEIVING AND DISTRIBUTING TANK.

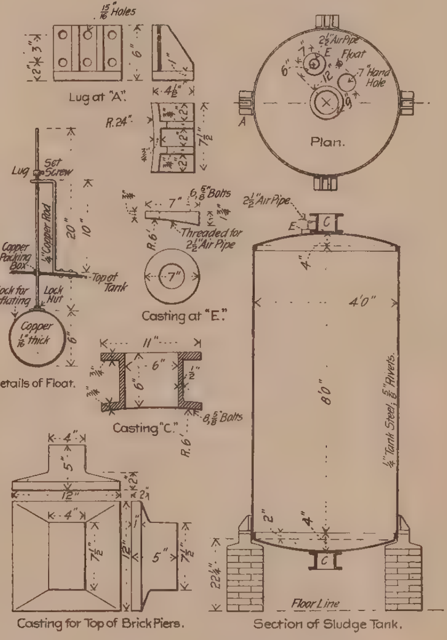
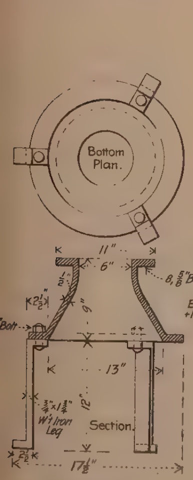


FIG. 10. SLUDGE TANKS.



Bell Mouth Inlet to Sludge Pipe.

OF SLUDGE PIPE.

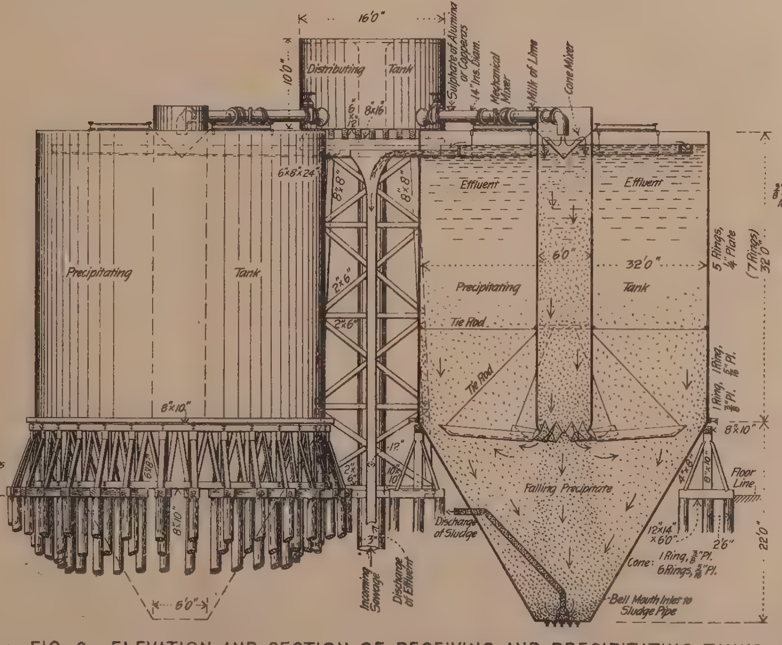


FIG. 2. ELEVATION AND SECTION OF RECEIVING AND PRECIPITATING TANKS.

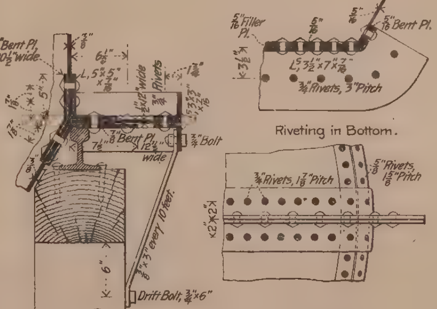


FIG. 8. DETAILS OF RIVETING AND SUPPORTING CONICAL PART OF PRECIPITATING TANKS.

THE SEWAGE PURIFICATION PLANT OF THE WORLD'S COLUMBIAN EXPOSITION.

W. S. MacHarg, Engineer of Water Supply, Sewerage and Fire Protection.

CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

incidental advantage as accompanies storage. It should be added that storage has some grave disadvantages, as is generally well known, principal among which are the tastes and odors imparted to stored waters at different seasons by algae and other forms of life and by stagnation.

Natural filtration is also an incidental advantage arising from a certain mode of developing a water supply. Although man has little to do with it save to make its results available some of the methods employed to this end are worthy of consideration, but with one exception they need not be discussed here. The exception noted is infiltration galleries or wells located near, and designed to draw water from a stream or lake, by means of percolation through the intervening sand or gravel. In general it may be said that such infiltration galleries and wells have eventually proved inadequate, owing to the gradual silting up of the interstices through which the water passes. When this silting up is caused by organic matter the water is liable to actual deterioration in quality. The experience of Lawrence, Mass., with an infiltration gallery is given in another column. These observations regarding inadequacy and deterioration are not intended to apply either to driven wells or to galleries in water bearing strata having a flow independent of surface streams, for in such cases the water percolates for a long distance through filtering material, so that if the supply be not too heavily drawn upon or directly polluted, as from surface sources, it is likely to remain of a satisfactory character.

Artificial filtration through filter beds, boxes and cribs may next be considered.

Although Richmond, Va., tried filtration as early as 1831, it soon abandoned it, and while many other cities also tried it during the next 40 years, it does not appear that any thoroughly satisfactory results, or, at least, any which would be considered satisfactory in the light of modern knowledge of the subject, were obtained until the filter beds of sand and gravel, at Poughkeepsie, N. Y., were built in 1870. These beds were designed by Mr. Jas. P. Kirkwood, who, as chief engineer of the St. Louis water-works during their enlargement, begun in 1865, visited Europe and studied purification processes there in vogue. His report to the St. Louis water commissioners was published in 1869, with illustrations, under the title of "Filtration of River Waters," and is still a valuable treatise on the subject, in fact the only American work wholly devoted to water filtration, we believe, except Prof. Wm. Ripley Nichol's report "On the Filtration of Potable Water," reprinted from the Ninth Report of the Massachusetts State Board of Health (1874). Mr. Kirkwood recommended the filtration of the Mississippi River water for St. Louis, but sedimentation was adopted instead, as mentioned above, and the city of Poughkeepsie received the benefits of his studies abroad.

Following more or less closely the example set by Poughkeepsie, a few other American cities have constructed filter beds, but none have improved on the Poughkeepsie plant, and most have fallen far behind it. Many of the attempts at filtration have been useless or worse than useless through lack of capacity or provisions for cleaning. The actual results obtained by the various filter boxes and cribs that have been employed might often have been surpassed by the use of properly constructed screens at gate houses or the mouths of intake or supply pipes.

The cost of land sufficient for sand filter beds of proper size and the cost of constructing and operating them, together with the reluctance of Americans to spend money to improve the quality of their water supplies, and, most important of all, the belief for some time current here that sand filtration alone is only a straining process, explain in part why more cities have not followed the example of Poughkeepsie and constructed sand filter beds of ample area.

This leads to the development and adoption of the mechanical or commercial filter which has taken place practically in the last 10 years. The causes given in the preceding paragraph, coupled with the fact that to make their water supplies tolerable to sight many cities must purify them, and the desire to carry the purification process further than it was thought possible to do with old methods, set the American mind to work on the development of some simple, cheap and effective process of water purification. The result was a filter of sand, or sand and coke, generally inclosed and operating under heavy pressure, and thus at a rapid rate, with mechanical appliances for washing the filtering material without removing it, and, in the case of the most widely adopted filters, with the addition of a precipitant to the water before filtration, when needed, to enable the filtering material to do more effective work. In some cases aeration was combined with filtration. Thus the filters could be compressed within a small area, operated readily, and cleaned often and with comparatively little labor.

Some 60 of these mechanical filters are now in use in connection with American water supplies, to the vast improvement of the water which passes through them. They may be so operated as to remove color, matter in suspension and some portion of that in solution, together with bacteria, the extent to which they do these things being largely determined by the rate of filtration, the amount of precipitant used, the care with which they are operated, and, obviously, the condition of the water before treatment. The only other method of filtration at all comparable with them is downward filtration through sand filter beds, the filter boxes, cribs and similar devices heretofore employed, whether filled with sand, coke, charcoal, sponge or other material, being altogether too limited in size to give comparative results. It will be understood that household or domestic filters are not in mind in this connection, all discussion of these being reserved for a future article.

Looking at water purification abroad, especially in England and Germany, it is seen that ordinary sand filtration has long been very widely and almost exclusively employed for water supplies liable to animal pollution, and with a very favorable effect upon the healthfulness of the communities concerned. In this country the sanitary importance of pure water is only beginning to be appreciated by the people at large, and is thoroughly understood by only a few of those directly in charge of our water supplies, or, if understood, financial and political considerations keep the subject in the background. But a change is imminent. The joint use of our streams and lakes for sources of water supply and receptacles for sewage cannot be tolerated always, especially with our rapidly growing populations. Unpolluted water supplies are becoming more and more scarce, and the demands for pure water are increasing in urgency. Naturally we have been looking abroad to see what densely populated European countries do for pure water and we find sand filtration in use for water of doubtful purity, and that foreign sanitary experts claim that simple filtration removes bacteria as well as inert organic matter. We find at home a well developed system of mechanical filtration, combined at times with chemical treatment as an aid to filtration and with aeration. Naturally we ask which is the best, for we are beginning to see that in sanitary matters the best is none too good for us.

Years ago the people of Massachusetts began to realize that steps must be taken to prevent the pollution of their water supplies, and through their State Board of Health began to study stream pollution and later water and sewage purification. The experts found that while European cities were purifying both sewage and water there was a great lack of the data needed to enable engineers to decide what methods to adopt to secure the most satisfactory results at the least expense. Finally, the Massachusetts State Board of Health received authority to begin extensive experiments on the purification of sewage and water. The start was made at Lawrence six years ago, and the work has been continued ever since. The experiments have been conducted from the chemical and biological sides, under the direction of eminent experts, as has been often set forth in these columns, and as will be given more fully in a later issue.

For the present it is sufficient to state that the work at Lawrence has completely and satisfactorily demonstrated that the purification of both water and sewage by filtration through sand, when carried to its limits, is not a mechanical or straining process, but is a process of nitrification, dependent upon the presence in the sand of oxygen and bacteria, the bacteria always accompanying oxygen when organic matter is available as a food supply and disappearing when the food supply is exhausted. How to secure the most perfect nitrification of the organic matter in sewage and how most completely to remove the bacteria or other objectionable contaminations from water has been the aim of the Lawrence studies, and as a result many new facts have been developed.

Mr. Hiram F. Mills, C. E., a member of the Massachusetts State Board of Health, has designed a water filtration plant for the city of Lawrence in which he has made use of some of the principles evolved at the experiment station.

The Lawrence water purification plant is of especial interest because, unlike all other American plants, it has been built more to remove disease germs from the water than to improve its appearance. The Lawrence water supply is taken from the Merrimack River, only a few miles below the outlet sewers of Lowell. Lowell and other cities on the river above it have had excessive typhoid fever mortalities for some years, and Lawrence has suffered accordingly.

The Lawrence experiments have shown that intermittent sand filtration under proper conditions will remove practically all the bacteria from water when filtering at the rate of from 1,000,000 to 3,000,000 gallons per acre per day. The new Lawrence filter bed has an area of 2½ acres and is designed to filter 5,000,000 gallons per day, or 2,000,000 gallons per acre, all as fully described elsewhere in this issue.

With this filter bed in operation we may hope to have a practical test of the principles evolved in the experimental work. The advocates of the intermittent sand filtration of water claim all the sanitary results that are claimed for mechanical filtration, if not more. The Massachusetts board has not seen fit to experiment with mechanical processes, and no systematic and continued chemical and bacteriological studies of the results of mechanical filtration have ever been made, so far as we can learn. For the present, therefore, the two processes cannot be compared in detail, but they are bound to be compared by every one who goes carefully into the subject of water purification, and for this reason it is to be hoped that ample data regarding mechanical filtration will speedily be made available.

The future of water purification in America is full of promise, both as to results which may be expected from the two prominent methods in vogue and also as to the rapid extension of the practice. Wherever a good system is adopted the results cannot fail to be beneficial, if the plant is properly managed.

A NEW METHOD FOR TESTING STRUCTURAL STEEL.

It seems to us possible that one of the most notable advances recorded among the papers at the Engineering Congress held this week in Chicago, may prove to be that proposed by Mr. Alfred E. Hunt, of Pittsburg, in his paper describing a new method devised and perfected by himself for testing structural steel by the simple method of observing the resistance and work done in punching. This paper is published nearly in full, as its possible importance and utility seem to demand. The great advantages of the soft and medium grades of steel as structural materials are being so rapidly recognized that they bid fair before long to wholly supplant wrought iron as wrought iron supplanted cast iron and wood. We have already discussed the reasons for this several times and need not repeat them. At the same time the necessity of thoroughly testing all material entering into the construction of our large bridge and roof trusses, steam boilers and numerous other structures is as great as ever; perhaps even greater with steel, owing to its susceptibility to various hardening influences which may easily render it quite unfit for the purposes mentioned. A cheap, quick and certain method of determining quality within certain narrow limits is, therefore, a great desideratum.

It cannot be questioned that the tests for tensile strength, elongation, reduction of area, the various hot and cold bending tests, and the drop tests now practiced furnish a fair index of the qualities most essential in structural steel, tensile strength and ductility. It should never be forgotten, however, that these tests cannot be correctly assumed to give the metal the same strain, or rather combination of strains, which it must sustain in the member of the actual structure. Moreover, the unit strains which these testpieces will sustain without rupture are not the unit strains which a full sized member will sustain under exactly similar conditions. A little cold rolling of a testpiece will cause it to sustain strains far in excess of the mean or normal value of the strains which a full-sized section will sustain. Again, the present system of testing is in every respect inconvenient and laborious. It necessitates the cutting and working to shape of a considerable number of specimens for each melt of steel, requiring both time and cost. The bending and drifting tests are incapable of being numerically recorded, or even of a definite and accurate stipulation of requirements in specifications. A further point brought out by the paper referred to, which is not, it is true, the fault of the present system of testing, but rather of the specifications, is the too great narrowing of the limits of variation with a resulting excessive exclusion of material.

Evidently any method of testing steel which promises to obviate a portion even of these ills without reducing the reliability of the tests for indicating quality should be welcomed and thoroughly tested. Such a method Mr. Hunt thinks can be found by substituting a punching test—details of conducting which are given in the article referred to, and need not be given here—for the several tests now commonly made. The correctness of his theory must be decided by each one for himself, but we think that a brief study of the evidence submitted can only lead to the conclusion that it is a theory of much promise and probable utility.

The expense and labor of the present system of testing, certainly very important considerations, are largely done away with by the proposed method. It is possible by it not only to test the waste ends of bars without further working, but also the bars and other shapes themselves, and, as Mr. Hunt says, it will be perfectly practicable to equip the ordinary mill punches with the apparatus necessary to record the punching force exerted, and by the aid of a graphical device to record the characteristics of every piece of metal punched. In this respect the system presents a very marked superiority over the old method, by which the testing of each piece can by no means be undertaken within reasonable limits of time and cost.

All these conveniences are, however, of little moment unless the method will accurately indicate within reasonable limits the suitability of the metal for structural purposes. The crucial question is whether the punching test will show not only the qualities which a good structural steel should possess, but also the qualities which it should not possess. The tests made by Mr. Hunt indicate that it will, although it will require a far greater number of tests on certain points to establish the fact beyond doubt, or to enable a standard of requirements to be formulated which can be adopted in specifications. Expressed in another way, the tests point out a new and extremely promising line of advance toward better methods of testing structural material, but they do not yet establish, but only indicate in a general way, the limits within which this line of advance can be depended upon as safe.

Turning for the moment from the evidence given by the tests to inherent probabilities, strong reasons may at once be seen why the punching test should give a safe index as to that combination of ductility and tensile strength which is the characteristic of good structural material. The punching force is always an increasing force; beginning at nothing, it increases with greater or less rapidity to the maximum required to perforate the metal. The action of the tool, or punch, on the metal, however, varies with the characteristics of the metal. With a very hard steel the force exerted reaches a very high point, closely approaching the maximum in cases, before the tool has any appreciable effect, that is, before it begins to penetrate the metal. The force exerted up to a very high point does no work. When the punch does act, however, it acts very abruptly, the force exerted at the point of initial penetration remaining nearly constant through the process. The work done, then, is approximately the product of a regular force and the space traversed by it.

On the other hand, with a soft, ductile steel the tool begins to penetrate the metal long before the maximum force necessary to perforate it has been reached. The force begins to perform work almost at the beginning of the process. Here, then, contrary to the first case, or, perhaps, we should say, more nearly approaching the theoretical action than in the first case, we have something in the nature of a variable force acting through a certain space. The work done in this case, however, is not the product of an approximately constant number of pounds of force and of the space passed through, but is a number obtained by integrating between the proper limits the well known expression for work done by a variable force,

$$\int Fds.$$

Similarly, the work done between any two instants of time can be calculated. This being the case, it will be seen at once that by requiring a minimum work where the punching force exerted as one of the factors of the work is within given limits, we have a possible method of measuring the character of a steel by submitting it to a punching test and calculating the work done in perforating the plate. The method adopted by Mr. Hunt for measuring and recording the work and using the tests in actual practice are given in the paper. It will be seen that it is very simple.

In the foregoing we have neglected to consider the factors tending possibly to modify the results in actual practice; such as varying thicknesses of the metal, the rapidity of the punching process, the location of the punched holes, etc. Turning to the tests summarized in the paper it is seen that up to a thickness of ⅝ in. the punching force increases regularly with the thickness, and that beyond a thickness of ⅝ in. the action of the tool is such as to give unreliable results. Evidently, then, up to a thickness of ⅝ in. there is no difficulty in applying the punching test and securing correct results. Similarly, it will be seen that the variation of the speed of punching likely to occur in practice, may be neglected. The effect of the location of the holes, on the other hand, is more important, but even here the differences in punching force occasioned by differences in the location of the holes are far less than the differences occasioned by a difference in the quality of two metals. In respect to the possibility of distinguishing a weak or rotten metal or a burned metal there seems to be no great difficulty, if proper attention is paid to conducting the tests.

It will be seen from what has preceded, that the great preponderance of evidence is in favor of the practicability of the punching tests as a method for determining the suitability of a steel for structural purposes. No claims are made that the method will determine the tensile strength, but only that it furnishes a simple, convenient and comparatively inexpensive method of determining the ductility of the metal as compared with its tensile strength. Its one great advantage, aside from its cheapness and simplicity before mentioned, is that it can be made to give us the characteristics of all parts of the bar or other shape tested, and this, too, during the manufacture. It is a well known fact that testpieces cut from certain parts of the cross-section will give figures which are considerably, often 5% to 10%, higher both in ultimate strength and elongation than pieces cut from adjacent parts of the section, and that advantage is taken of this fact by manufacturers in cutting testpieces to meet different requirements. There is little doubt that the unit strength and the elongation as determined from the usual testpiece may be and, in fact, usually is, somewhat greater than the full sized section will show. This has led during recent years to the practice of testing full-sized members, mainly eyebars, for all important bridges. Of course, the punching test will not obviate this, and, in fact, unless a way is found (and there seems to be no good reason why there should not be) to punch steel over ⅝ in. thick with as accurate results as steel of less thickness, the test is not applicable to heavy bridge work at all; and the statement is only made to show that we are not discarding an old and perfect system of testing for a new and untried one when we substitute the punching test for the several now made.

A greater part of the steel structural work, however, is not in the shape of heavy bridges, but is in the shape of light bridge and roof trusses, steam boilers, stand-pipes, gas tanks and a dozen similar structures. In most of these cases the forces to be resisted are comparatively regular, and even if we exclude a punching test for more important and costly structures it can be used here with advantage. We may properly conclude, then, that the system proposed by Mr. Hunt points out a line of investigation of great promise for simplifying, cheapening and reducing the time and labor of testing structural steel, and, although more tests are required to establish certain points, the tests already made indicate that further investigations will prove the system one which can be depended upon within reasonable limits to reject a steel that has any of the injurious qualities that such metal is usually rejected for.

LETTERS TO THE EDITOR.

SLIDE RULES.

Sir: Please give me the benefit of your experience with "Slide Rules." What is the best make and where can it be had? Sincerely yours, Elmo G. Harris.

Rolla, Mo., June 12, 1893.

(The one which lies always on the desk of the present writer, and is perfectly satisfactory, bears the inscription: "Travernier-Gravet, 19 Rue Mayet, Paris," and was purchased of the Keuffel & Esser Co., of this city, who have several makes of their own, which have the advantage of a white instead of boxwood surface, and a "duplex" slide rule recently devised by Mr. Wm. Cox, of that company, and manufactured by them has certain prima facie advantages which we have not tested. It saves reversing the slide for certain computations. The two main requirements for a slide rule are that the readings on the two halves of the scale shall be absolutely coincident in all positions, and that the slide works freely in all positions without the use of any considerable force. Slide rules not having these two requirements should be rejected.—Ed.)

SLACK LIME FOR MARKING IN BLUEPRINTS.

Sir: I notice in your issue of 20th inst. a recipe for drawing red lines on blueprint paper. Let me add that a thin mixture of slacked lime and water gives a far clearer, sharper line than a carbonate of soda solution, and it will not spread over the paper. It can be used for either white or red lines. In the spring of 1888, after finding that the soda solution would spread, I tried carbonate of potash, caustic soda, caustic potash, chloride of lime and other substances, but found nothing as good as the lime.

As you may have no building going on near you, I inclose a small sample for trial. A teaspoonful of lime in a four-ounce bottle, with a wide neck and a rubber stopper, will last a year or two. It can be shaken up as required.

H. Irwin.

Montreal, P. Q., July 24, 1893.

(We have tried our correspondent's recipe with the result of getting very perfect white lines by taking care to have the solution (or rather, mechanical mixture) strong, but without any indication of red lines. The red is probably derived from an analine addition to the lime not mentioned by our correspondent.—Ed.)

THE FERRIS WHEEL IN A STORM.

Sir: During the storm of Sunday, July 9, I was unfortunate enough to be an unwilling passenger during that storm. I did not notice the storm when I entered the car. I was scarcely more than half up when the storm struck, taking flagpoles, signs and various other small articles. It took the combined effort of two of us to close the door tight, the wind blew so hard, and the rain drops appeared to be flowing almost horizontal instead of vertical. There was a slight vibration; the wheel vibrated sideways, perhaps 1½ ins. out of its normal position. The wind blowing against the rods and bracings was all that could be felt. I thought these facts might be of interest to you.

Yours truly,
G. P. C.

(The storm was a very severe one and this result confirms our impression that the wheel is amply strong against anything but a genuine tornado, which latter, of course, cannot be resisted by any such wheel any more than by an iron bridge. The vibration spoken of is no more than was inevitable with a 250-ft. wheel extending 264 ft. above the ground.—Ed.)

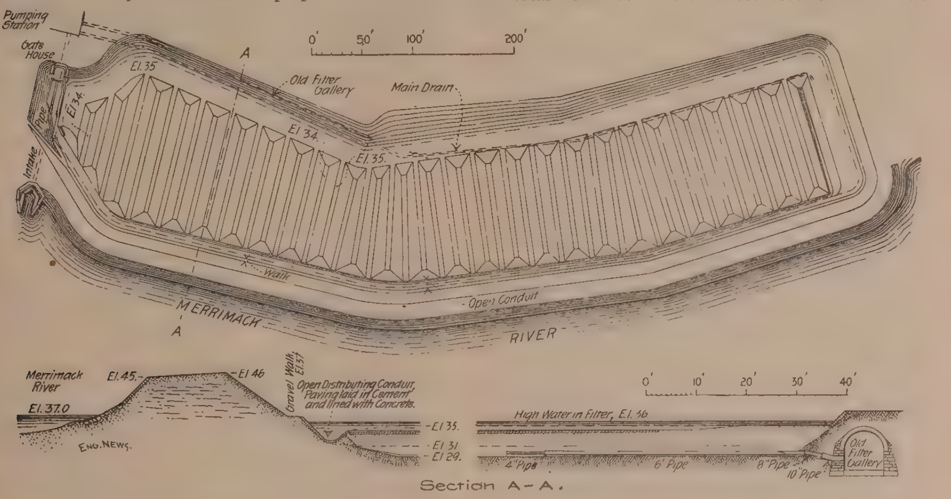
A NEW TELEMETER TARGET.

Sir: In your issue of July 13, p 26, you describe a new "telemeter target," and give some formulas for use with it. I think that you are in error in applying a correction for the angle of elevation or depression. The horizontal angle subtended by the targets will be the same whether the targets are a hundred feet lower or higher than the instrument or on a level with it. I have used an ordinary leveling rod for the same purpose where great accuracy was not required. Drive a stake in the ground at the point whose distance is required and rest one end of the rod on it, letting it be held as nearly horizontal and perpendicular to line of sight as may be. Turn off on instrument one or two degrees, read rod, and multiply reading by Cotan of angle. This can be done with an instrument which has no vertical circle. Yours truly,

A. D. Wilson.

Deadwood, S. Dak., July 19, 1893.

(Our correspondent is right, as noted in commenting upon the letter from another correspondent in our issue of July 20.—Ed.)



Section A-A.

FIG. 1. PLAN AND SECTION OF WATER FILTRATION BED, LAWRENCE, MASS.; HIRAM F. MILLS, DESIGNING ENGINEER.

WATER PURIFICATION IN AMERICA.—1.

Lawrence, Mass.

When the water-works of Lawrence were built in 1873-5, it was considered desirable to purify the water of the Merrimac River, especially during the spring freshets, and to that end a filter gallery was built near the river bank. This gallery was 300 ft. long and 8 ft. wide, giving a bottom area of only 2,400 ft. The walls were of rubble, 4 ft. high to the spring line of the semi-circular brick arch which covered it. The bottom was covered with 1 ft. of broken stone and is 15 ft. lower than the crest of the dam below the pumping station.

The yield of the gallery very soon fell below the demand for water, so that as early as 1876 a canal was cut from the river parallel to the gallery to diminish the distance through which the water must pass and thus to increase the supply.

The report of Lawrence Water Board for 1878 contains the following regarding the filter gallery and the need of some different system of filtration:

> The canal constructed in 1876 between the river and filter gallery has been enlarged the last summer (1877), resulting in an increased flowage of water through the gallery, but not sufficient to wholly supply the present and much less the prospective wants of our increasing population.
>
> If we would secure at all times an adequate supply of filtered and wholesome water the time is very near, if indeed it has not already come, when the method of filtration must be materially improved and the capacity enlarged; and this evidently must be accomplished by some other and more effective process than by an uncovered channel in so close proximity to the gallery.

The filter gallery was never extended, and the yield from it has always remained small, increasing with high water, when the benefits from it seem to have been greatest by means of a reduction of turbidity.

The report of the Water Board for 1883 contained the following:

> It is apparent that the earth about the filter gallery is gradually silting up and the yield from it lessening. This may not, however, be considered a calamity in view of facts brought to light by a reliable analysis conducted under the direction of the Board of Health, showing the water from the gallery to be much inferior to that taken direct from the river, making it seem evident that the gallery is supplied largely from landward, its waters partaking of the same properties found in wells throughout the city.

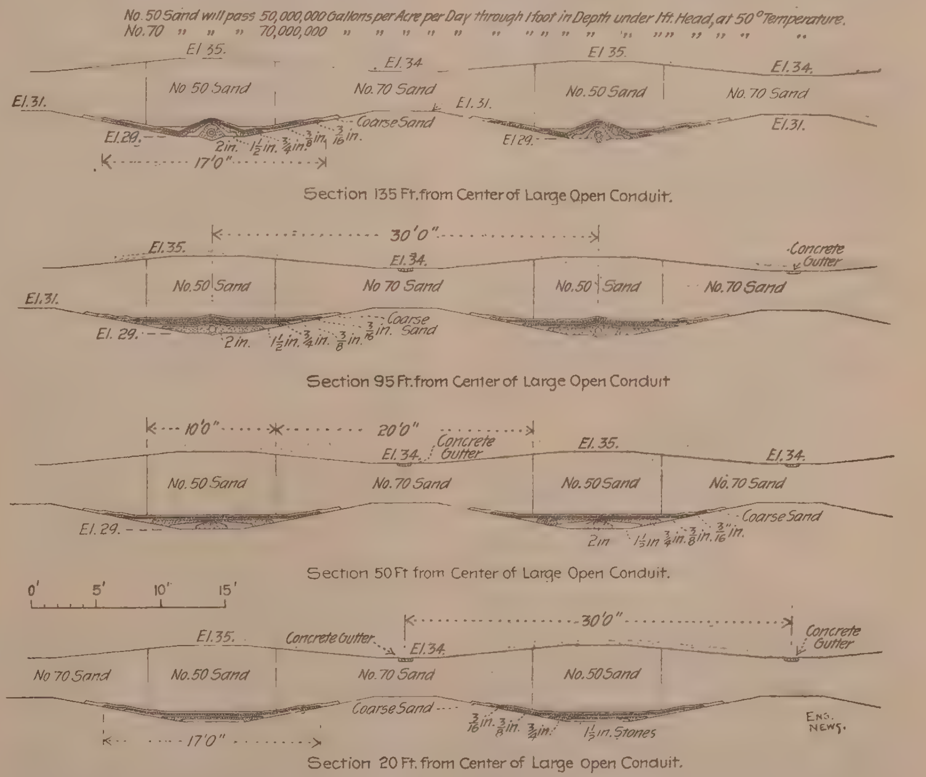
In July, 1875, a single analysis each of river water and water from the filter gallery showed the following results in grains per U. S. gallons:

	River.	Gallery.
Organic and volatile matter	1.14	1.08
Mineral and saline matter	3.40	4.73
Total solids	4.54	5.81

The organic and volatile matter in water from the gallery was thus only some 5% less than that from the river, while the mineral and saline matter was nearly 28% more, the excess, it is stated, being largely carbonate of lime.

The population of Lawrence in 1870 was about 30,000; in 1880, 39,151; in 1890, 44,654. The water consumption in 1877 was 1,554,058 gallons; in 1880, 1,866,449; in 1890, 2,770,000, and in 1892, 3,597,420 gallons.

Allowing a flow into the gallery of 100 gallons per sq. ft. of bottom per day, it would have yielded only 240,000 gallons at the start, about one-sixth the consumption in 1877, and one-fifteenth that of 1892. This may be considered a low rate of infiltration, but from the few figures available it is doubtful whether it was ever much exceeded at Lawrence after the first few years, except, perhaps, in times of freshets.


No. 50 Sand will pass 50,000,000 Gallons per Acre per Day through 1 foot in Depth under 1ft. Head, at 50° Temperature.
No. 70 " " " 70,000,000 " " " " " " " " " " " " " " "
El 35.
El.34
El.31.
El.29.
No 50 Sand
No.70 Sand
Coarse Sand
2in. 1½in. ¾in. ⅜in. 3/16in.
17'0"
30'0"
Concrete Gutter
20'0"
10'0"
1½in. Stones
Eng. News.
0' 5' 10' 15'

Section 135 Ft. from Center of Large Open Conduit.

Section 95 Ft. from Center of Large Open Conduit

Section 50 Ft from Center of Large Open Conduit.

Section 20 Ft. from Center of Large Open Conduit.

FIG. 2. SECTIONS OF LAWRENCE FILTER BEDS, SHOWING ARRANGEMENT OF FILTERING MATERIAL.

Lawrence is one of the three Massachusetts cities, out of 16 which have been carefully studied, where the introduction of a public water supply has not materially reduced the death rate from typhoid fever, while only a couple of years or so ago an epidemic of the disease was rife in Lawrence, following closely upon a similar epidemic at Lowell. Lowell, like several other typhoid afflicted cities on the Merrimac River, above Lawrence, discharges its crude sewage into the Merrimac River, from which Lawrence draws its water supply, its intake being located only nine miles below the Lowell outlet sewers. A careful study of the situation by the Massachusetts State Board of Health convinced it that a polluted water supply caused the excessive death rate from typhoid fever in Lawrence.

The chairman of the Committee on Water Supply of the State Board of Health, Mr. Hiram F. Mills, C. E., of Lawrence, has directed the work of the Lawrence experiment station of the Board in its investigations of water and sewage purification. Some of the investigations regarding water filtration have been carried out with the Lawrence supply specifically in mind, the city extending a service pipe to the experiment station with this directly in view. Mr. Mills also made a careful study of typhoid fever in its relation to water supplies, and in conjunction with the State Board of Health warned the people of Lowell that their water supply was unsafe. In 1892 the city began the construction of a filter bed after the design of Mr. Mills and with him as consulting engineer.

As the Lawrence filter bed is in a sense the outcome of the work of the Lawrence experiment station and seems likely to mark an era in American water purification, it seems fitting that a description of it should be given as the beginning of the series of articles on Water Purification in America, alluded to in the editorial columns of this issue. Mr. Mills has very kindly sent us the drawings of the filter bed, given herewith, and also the following facts:

The area of the filter bed is 2½ acres and its proposed daily capacity is 5,000,000 gallons, or 2,000,000 gallons per acre. It is separated from the Merrimac River by an embankment made up of the material excavated from the site of the bed. This excavation was carried to a depth of 7 ft. below low water in the river, and the embankment is designed to exclude the highest spring freshets. The general level of the surface of the filtering sand filled into the excavation is 2½ ft. below low water in the river and is flooded to a depth of 1½ ft. by water which enters through a 2-ft. gate and flows through an open conduit at the foot of the embankment. This channel has a paving laid in Portland cement and lined with Portland cement mortar. The water from the conduit overflows into very shallow distributing conduits of the same material which cross the bed nearly its full width, once in 30 ft., all as shown by the plan and sections, Figs. 1 and 2. The bottom of the excavation has cross ridges directly below the distributing conduits, and thus 30 ft. c. to c., which are 2 ft. higher than the depressions between. In the depressions for a part of the way across the bed are small drain pipes laid with joints so open that the spigot does not enter the bell, and these are surrounded by a 4-in. layer of stones, 2 ins. in diameter or larger. Outside of and upon this layer of stones are four other layers of selected stones, each wider than the one beneath it, as shown in the sections, Fig. 2, having diameters of about 1½, ¾, ⅜ and 3-16 in. The upper layer of stone is covered with about 1 in. of coarse sand which spreads somewhat beyond it. The full depth of the stones is about 1 ft., while the layer of smaller stones or the upper layer spreads to a width of 17 ft.

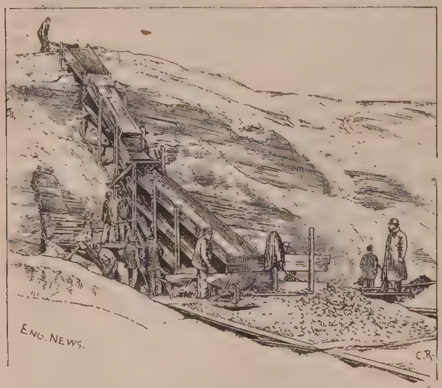


Fig. 3. View of Gravel and Sand Screening Apparatus.

The surface of the bed of filtering sand has depressions ranging in depth from 1 ft. to nothing extending nearly across the bed once in 30 ft. and corresponding with the distributing conduits. When the lower part of the filtering material becomes full of water the water rises up the slopes and finally covers the upper level of the sand to a depth of 1 ft., at which height it remains during the greater part of the day. The filtered water passes through the underdrains to a brick conduit and through the old filter gallery to the pump well.

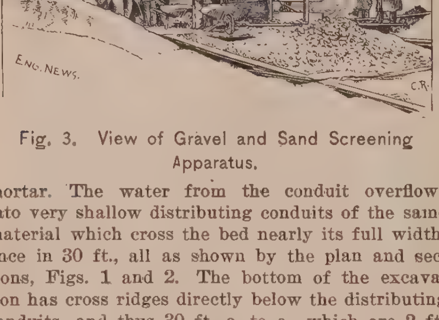


Fig. 4. Elevation of Gravel and Sand Screening Apparatus.

The pumps run about 19 hours a day. About five hours before they stop the inlet gate supplying the filter bed from the river is to be closed, and the pumps continuing will uncover the surface of the sand and drain the sand nearly to the bottom and allow it to fill with air. The inlet gate is to be opened again about an hour before the pumps start, when the sand is filled and gradually overflowed. This intermission once in 24 hours is found by the experiments of the Massachusetts State Board of Health to be sufficient to give to the filter the advantages of intermittent filtration.

The filtering sand is of two kinds, as shown by the sections. No. 70 sand covers the ridge of the bottom with a depth of only 3 ft. and extends for a width of 20 ft. It has grains, the finer 10% of which have diameters equal to and less than 0.3 mm., or 0.118 in., and when clean will allow 70,000,000 gallons of water to pass through any depth when the acting head is equal to that depth. Directly over the underdraining stones for a width of 10 ft. is a somewhat finer sand, whose finer 10% have diameters equal to and less than 0.25 mm., or 0.098 in., and which when clean will allow 50,000,000 gallons of water to pass through any depth when the acting head is equal to that depth or the distance through which the water moves.

It is desirable that the head used shall not be more than 1 ft. in either case, and the distance through the sand to the underdraining stones is in the former case 7 or 8 ft., in the latter 5 or 6 ft., reducing the quantity of water that can pass either sand to 8,000,000 or 10,000,000 gallons per acre per day, which quantity will in time be reduced to perhaps 5,000,000 gallons per acre by the very slow infiltration of fine river silt into the body of the sand. This silt will, however, be nearly all retained upon or very near the surface, there obstructing the entrance of the water; and to maintain an even passage of 2,000,000 gallons per acre per day it will be necessary to remove from the whole surface of the bed from ⅛ to ¼ in. of sediment and sand each month, and a larger amount during the spring freshet, when much sediment is brought down the river. The sand removed is to be replaced at the time by clean sand.

By the present arrangement of a single bed it is necessary to remove the sediment daily or nightly when the water is drawn below the surface. It is designed shortly to build another bed up the river to be supplied by the duplicate inlet gate.

On July 31 about three-fourths of the sand had been placed in the filter bed, and it was thought that water would be let on early in September. The appropriations made thus far for the whole plant have amounted to $55,000, but the expenditures have not reached that amount.

From the foregoing description by Mr. Mills, and from the fact that the rate of filtration and to a large extent its success depend upon the uniform distribution and gradation of the filtering materials, it will be apparent that the selection and screening of the filtering materials were of great importance. The screens used, or more correctly their ingenious arrangement, as shown by the view, Fig. 3, and the elevation, Fig. 4, were designed by Mr. Allen Hazen, Chemist in charge of the Lawrence Experiment Station. It will be seen that the screens are so arranged that the sand and gravel can be brought indiscriminately from the bank, thrown into the upper end of the screens and removed assorted in proper sizes from the compartments below. The process leaves scarcely anything to the judgment of the laborers after fairly put in operation. It was found that, if screens with a width greater than 2 ft. 7 ins. were used, the wire would sag, of course with unsatisfactory results.

Only a portion of the main body of filtering sand required screening, a suitable quality having been found for the remainder.

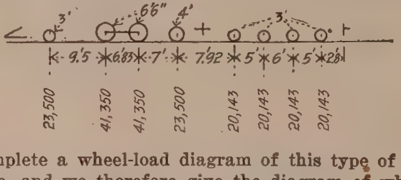
In the last report of the Lawrence Water Board it is stated that the faces and top of the river embankment are of gravel, and in its center there is a puddle wall of river silt to prevent the infiltration of river water.

It may be added in conclusion that if the cost of the filter beds is within the appropriation, $55,000, and the proposed capacity of 5,000,000 gallons daily is obtained, the cost per 1,000,000 gallons will be $11,000. This will be a comparatively low cost, especially if 98% of the bacteria are removed by filtration; as the above-named report states is expected from the plant. It is interesting to note that the city of Lowell, which also draws its water supply from the sewage-polluted Merrimac River, is constructing a driven well plant of 5,000,000 gallons daily capacity, instead of attempting to filter the Merrimac River water. It is reported that this plant will cost about $100,000. The comparative results obtained by the two cities will be awaited with interest.

Mr. A. D. Marble is city engineer of Lawrence and Mr. A. H. Salisbury is superintendent of water-works.

LOCOMOTIVE WHEEL-LOAD DIAGRAM; DOUBLE-END LOCOMOTIVE, P. & R. R. R.

The new type of "double-end" express locomotive which has been introduced on the Philadelphia & Reading R. R., was described and illustrated in our issue of June 15. A correspondent has asked us for some further dimensions to enable him to complete a wheel-load diagram of this type of engine, and we therefore give the diagram of wheel base and wheel-loads. The engines were built by the Baldwin Locomotive Works, Philadelphia, Pa.



THE DRAINAGE MACHINERY OF THE NETHERLANDS.

The large use of drainage machinery in the Netherlands has led Dutch engineers to pay particular attention to its development, especially in the line of economy in fuel consumption. In a short paper presented before the Mechanical Engineering Section of the International Engineering Congress, Mr. A. Huet, of Delft, Holland, presents a series of papers relating to the subject, and also refers to the exhibits of the Royal Institution of Engineers in the Dutch section of the exhibition. As the subject is likely to prove of interest to many engineers, we give the paper nearly in full, as follows:

> The rise of the Dutch Republic in the sixteenth century was followed in the seventeenth century by a remarkable development in the art of draining the lowlands, which had been so valiantly rescued from a foreign yoke. Simon Stevin, the teacher of Maurice of Nassau, gave the theory of wind water-mills. Leeghwater drained a series of deep lakes with scoop-wheels arranged in three tiers. In the eighteenth century Obdam introduced the water-screw, and Eckhardt the inclined scoop-wheel. In the first years of the nineteenth century Peereboom applied the horizontal centrifugal pump. Thirty years later Lipkens made his single-acting pump for the Haarlem Lake, and Fynje gave his double-acting pump. In 1776, Hoogendyk made the first application of an atmospheric engine, and in 1786 he built the first single-acting steam engine for drainage work. In the first half of this century Simons pleaded successfully for the application of steam to the draining of the Haarlem Lake, which he and Lipkens realized in 1845 by the three pumping engines, together of 1,000 HP., with high-pressure steam, compound action and condensation.
>
> The history of the development of drainage machinery in the Netherlands has been given by the author of this notice in "Stoombemaling van polders en boezems" (The Hague, 1885). A series of papers read by the author in the Royal Institution of Engineers has relation to the same subject; copies of these form a reference appendix to this communication, and will be briefly referred to: (1) List of drawings of draining machinery sent to the Paris Exhibition of 1889. (2) Graphical treatment of the design for draining machinery with variable height of lift. (3) Simplified design for the inclined scoop-wheel in cast and wrought iron. (4) Perfected design of the water-screw in wrought iron, and a graphical calculation of the water discharge. (5) Application of compound rotating steam engine to single-acting pumps. (6) Architectural design for same. (7) Application of compound engines to double-acting pumps. (8) Graphical calculation of the allowed height of suction with pumps of great piston velocity.
>
> These papers are offered with the intention that at the expiration of the Congress they may be given to the American Society of Mechanical Engineers. The leading thoughts in these papers are: (1) The application of modern machine design to those types of drainage machinery generally adopted in the Netherlands. (2) The reduction of the coal used in draining to the limit of 1.5 kilograms (3.3 lbs.) per useful horse-power in water lifted, which may be considered as possible. (3) The demonstration that by the use of single and

double-acting pumps a lower limit may be expected in the consumption of fuel.

The great interest of this question will be appreciated when it is known that for the drainage of the Zuiderzee at least 10,000 HP. will be wanted. The Haarlem Lake at present consumes fifty Dutch florins per horse-power yearly for coal and lubricants, because the consumption of fuel in the course of time has grown to 3 kilos. (6.6 lbs.) per useful horse power in water lifted. The reduction to 1.5 kilos. per horse power, would lead to a yearly expense of only 25 florins per horse power, which would be equivalent to a saving of 250,000 florins yearly in the drainage of the Zuiderzee.

In the Dutch section of the Columbian Exhibition, among the display of the Royal Institution of Engineers, is given a series of three designs for drainage establishments in the Zuiderzee, each for a discharge of 360 cu. m. per minute, and a height of lift of 4.5 to 5.5 m. One of these designs has double-acting pumps, a second has centrifugal pumps, and a third single-acting pumps. An inspection of the drawings will show that with the centrifugal pumps the machinery is partly beneath the high-water level, which is always a disadvantage in case of flooding. The series of three designs named above has been made by students according to the plans of the author. He regrets that he cannot be present at the Congress, but if he is allowed to propose a conclusion, it will run as follows:

The consumption of fuel for well-designed draining stations should not exceed 1.5 kilos. (3.3 lbs.) of ordinary coal per useful horse-power in water lifted per hour. This consumption may be reduced by the use of well-designed single-acting or double-acting pumps, driven by compound or triple-compound engines with tubular boilers and surface condensation. The utmost limit which may be considered as attainable is 1 kilo. (2.2 lbs.) of good coal per useful horse power per hour in water lifted.

TESTS OF M. C. B. COUPLERS.

The substance of the report presented at the annual convention of the Master Car Builders' Association by the committee appointed to conduct tests of different makes of couplers of the M. C. B. type, was given in our issue of June 22. We present this week the committee's table of summary of the drop tests, which we have rearranged in order of the greatest average resistance to fracture. The description of the method of conducting the tests was given in the issue above referred to.

Summary Statement of Results of Drop Tests of M. C. B. Couplers.

(Rearranged by Engineering News in order of Greatest Average Resistance to Fracture.)

	Average weights.		Number of blows to break and where broken and cracked.													
			Coupler No 1.			Coupler No. 2.			Coupler No. 3.			Coupler No. 4.			
Name of Coupler.	Couplers complete.	Kn.	Blows.	Brok. in.	Crack. in.	Blo's.	Brok. in.	Crack. in.	Blows.	Brok. in.	Crack. in.	Blows.	Brok. in.	Crack. in.	Average blows delivered.
Chicago	221.5	53.3	21	Hd.	....	20	Hd.	....	12	Kn.	....	16	Hd.	....	17¼
United States	244.9	70.0	20	Not broken	....	11	Kn.	Sh.	20	Not broken	....	14	Kn.	....	16¼
American	225.3	52.4	15	Kn.	....	10	Kn.	....	15	Kn.	....	10	Kn.	....	12½
California	225.3	35.9	13	Kn.	....	11	Kn.	....	13	Kn.	....	13	Kn.	....	12½
Standard	225.5	67.0	6	Hd.	....	9	Hd.	....	9	Hd.	....	10	Hd.	....	8½
Drexel	205.8	57.8	10	Kn.	....	7	Kn.	....	10	Kn.	....	6	Kn.	....	8¼
Hinson	223.5	52.8	9	Kn.	Hd.	5	Sh.	....	9	Sh.	Hd.	7	Sh.	....	7½
Buckeye	229.8	56.3	10	Sh.	Hd.	4	Sh.	....	5	Sh.	....	8	Sh.	....	6¾
*National	213.3	51.4	4	Kn.	Sh.	8	Kn.	....	6	Kn.	....	8	Sh.	....	6½
Williams	209.5	42.9	7	Kn.	Sh.	7	Kn.	Hd.	6	Sh.	....	5	Sh.	....	6¼
Brown's E. Link	232.0	36.1	6	Kn.	....	6	Kn.	....	7	Kn.	....	4	Kn.	....	5¾
Thurmond	213.8	50.5	9	Sh.	....	3	Sh.	....	7	Sh.	....	2	Sh.	....	5¼
Gould	203.9	36.1	5	Hd.	....	4	Sh.	....	5	Hd.	....	5	Sh.	....	4¾
St. Louis	217.0	61.5	5	Kn.	....	5	Kn.	....	4	Kn.	....	5	Kn.	....	4¾
Empire	203.0	36.1	4	Hd.	....	4	Hd.	....	4	Hd.	....	6	Hd.	Sh.	4½
Janney	217.4	36.5	5	Sh.	Hd.	4	Sh.	....	4	Sh.	Hd.	..		....	4⅛
Trojan	219.3	51.8	3	Sh.	....	4	Sh.	....	4	Sh.	Hd.	4	Sh.	....	3¾
Johnson	183.1	36.1	5	Sh.	Hd.	3	Sh.	Hd.	3	Sh.	....	3	Sh.	....	3½
Rivers	254.1	80.3	1	Hd.	....	2	Hd.	Sh.	2	Hd.	Kn.	2	Hd.	....	1¾
Ludlow	None tested.														

Hd. = head; Kn. = knuckle; Sh. = shank.

* Formerly called "Perfected."

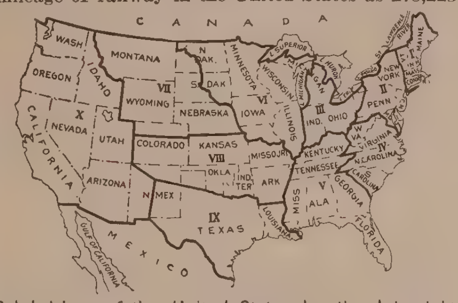
STATISTICS OF RAILWAY OPERATIONS IN THE UNITED STATES.

The issue of "Poor's Manual of Railroads" for 1893 and the report of the statistician of the Interstate Commerce Commission for the year ending June 30, 1891, are issued the same week this year. The statistics in the manual purport to cover the last calendar year, but as the reports of the railway companies must be accepted for whatever fiscal year they may have, they cover no particular year accurately; while those of the commission's report are over two years old, but cover accurately the year which they purport to cover. This makes the large mass of figures given in each somewhat difficult of concise consideration in the same article and almost impossible of comparison. We give below, however, some of the more salient features presented by each, arranged to supplement each other as far as possible.

Railway Mileage.—The commission's report gives the total mileage of railway line in the United States on June 30, 1891, as 168,402 miles, an increase of 4,805 miles over that of the previous year. This net increase, however, does not show the new construction, which was somewhat greater, since the figures take account of the decrease in mileage from line abandoned and other changes caused by straightening the track, remeasurement, etc. The mileage of line abandoned is given as follows:

	No.	Line owned.	Line operated.
Road abandoned	5	28	24
Road abandoned and track taken up	11	113	122
Totals	16	141	146

On Dec. 31, 1892, the manual gives the total mileage of railway in the United States as 175,223 miles, of which 4,429 miles were constructed during the calendar year of 1892. The results of operations are given for only 171,866 miles, however.



Subdivisions of the United States by the Interstate Commerce Commissioner's Statistician.

An interesting table in the commission's report shows the mileage of line per 10,000 inhabitants and per 100 square miles of territory in each state and in the United States, and discloses the greatest diversity of railway conditions, as will be seen by comparing the conditions in the following states selected from the table:

	Total mileage.	Miles per 100 sq. ms.	Miles per 10,000 inhabitants.
Nevada	931	0.85	199.5
Wyoming	1,021	1.06	164 8
Arizona	1,092	0.97	179.5
Massachusetts	2,089	26.	9.15
Rhode Island	221	20.4	6.28
New York	7,711	16.2	12.6

The states having the largest mileages of railway do not differ materially in their relative order from preceding years. According to the manual, which gives the latest figures, the State of Illinois leads with 10,349 miles. Pennsylvania and Texas each have over 9,000 miles, and New York, Ohio, Kansas and Iowa between 8,000 and 9,000 miles. The state of Rhode Island has the smallest mileage, 223 miles.

For further comparison the actual mileage and the mileage per 100 square miles and per 10,000 inhabitants in each of the several groups shown in the map, Fig. 1, are given in the following table arranged from the commission's report:

Group.	Mileage. 1891.	Miles per 100 sq. ms.	Miles per 10,000 inhabitants.
I	6,930	11.18	14.47
II	19,017	17.55	13.54
III	22,012	17.47	25.71
IV	9 834	7.07	19.5
V	19,503	6 51	21.11
VI	37,890	10.18	36 20
VII	9,385	2.27	64.17
VIII	20,776	5.69	41.41
IX	10,173	3.14	33.51
X	12,877	1.69	53 97
U. S	168,402	5.67	26.29

The mileage of second, third and fourth track and yard track and sidings is shown in Table I. It will be seen that 56% of the total 8,865 miles of second track is in the states of New York, New Jersey, Pennsylvania, Delaware and Maryland comprising Group II., and that the remainder is about equally divided between the New England, North Central and Northwestern States. Nearly all of the third and fourth track is in the Middle States, or Group II., also. The figures for yard track and sidings are partial, as they give this class of track only for those roads reporting it. It may be noted here all the computations in the report are based on the 161,275 miles of railway reporting to the commission.

TABLE I.—Showing Mileage of Second, Third and Fourth Track and Yard Track and Sidings, by Groups.

Group.	2d.	3d.	4th.	Yard and siding.	Total trackage.
I. New England	1,264	30	24	2,310	10,350
II. Middle	4,962	684	510	8,151	32,743
III. North Central	1,178	20	3	6,490	28,627
IV. South Atlantic	85	..	..	1,350	11,281
V. Ky., Tenn., Gulf.	19½	..	150	2,342	19,299
VI. Northwest	1,177	78	61	7,994	47,251
VII. Rocky Mountain	14	..	..	1,415	10,811
VIII. Cent. Western	113	1.83	1.43	3,043	23,428
IX. Southwest	....	..	..	1,012	10,499
X. Pacific	53	..	..	1,604	13,155
United States	8,865	813	750	35,742	207,446

As Poor's Manual gives the second, third and fourth track, etc., in a lump sum it is impossible to give the mileage of second track at the beginning of this year. The total miles of track in the country at that time is, however, given at 221,628 miles, of which 49,823 miles are other than single track.

Organization of Property for Operation.—From the commission's report it appears that the tendency toward consolidation is increasing. On June 30, 1891, there were 1,785 railways having a separate legal existence, a decrease of 12 from the preceding year, and of these 889 maintained separate operating accounts, and 35 were independent roads not in operation. Of the 889 roads maintaining separate operating accounts, 180 were leased lines. The total number of subsidiary companies was 747, an increase of 11 over the preceding year. During the year 92 roads, representing a mileage of 10,116 miles, ceased to have an independent legal existance through purchase, merger and consolidation.

Of the operating companies a comparatively few control the bulk of the mileage. The following table brings this out very clearly:

Mileage.	No. corporations. 1891.	No. corporations. 1890.	Proportion of aggregate mileage to total mileage. 1891.	Proportion of aggregate mileage to total mileage. 1890.
Over 1,000 miles	41	40	56.05	47.51
1,000 to 600	25	33	11.35	15.1
600 to 400	25	30	7.63	9.59
400 to 250	40	46	7.69	8.92
Under 250	*860	864	17.28	18.88
Totals	991	1,013	100	100

* Includes 102 private roads.

The number of companies operating over 1,000 miles has increased one during the year, and the increase in the proportion of the mileage of this class to the entire mileage of the country is 8.54%. All other classes have decreased both in the number of roads and in the mileage controlled. This furnishes further evidence of the fact that the railways of the United States are gradually being consolidated into a comprehensive system.

Rolling Stock.—The value of the statistics of rolling stock furnished by the commission's report is somewhat impaired, owing to the fact that the cars owned by companies such as the Pullman and Wagner, the refrigerator car companies and others are not included. As is well known, the number of these cars has increased largely within a few years. The following table shows the quantities and classes of rolling stock in use, excluding the classes just mentioned:

	Number.	Increase p. c. over 1890.
Locomotives.		
Passenger	8,901	4.5
Freight	16,696	3.5
Switching	4,321	5.04
Unclassified	2,221	3.96
Total	32,139	6.2
Cars.		
Passenger	27,919	4.
Freight	947,300	3.05
Company's service	35,185	6.48
Fast freight line	51,787	1.54
Cars leased	153,390	1.42
Totals	1,215,611	3.79

The number of locomotives per 100 miles of line is 20, and the number of freight cars per 100 miles of line is 684. An especially significant fact brought out by the detailed tables, from which the above is abstracted, is that the increase of cars leased is nearly equal to the cars assigned to freight service owned by the companies, and that there is a corresponding increase in the "equipment trust obligations." There is also a decrease of cars assigned to fast freight lines amounting to six per 100 miles of railway operated.

Automatic Brakes and Couplers.—The statistics on this point are, of course, too ancient to be of much more than historical interest. The following table compiled from the commission's figures shows the total rolling stock equipped with train brakes on June 30, 1891:

	June 30. 1891.	Inc. ove 1890.
Passenger locomotives	8,516	211
Freight "	10,754	1,226
Switching "	2,031	193
Unclassed "	1,793	1,187
Total	23,094	2,817
Passenger cars	27,246	1,607
All other cars	137,992	35,081

The chief point of interest is, of course, the rapidity with which automatic couplers and brakes are coming into use. This is shown in the following table:

	Total. equip't.	Inc. %	Equip. f't'd with tr. brk.	Inc. %	Equip't f't'd with aut. coupler.	Inc.
1892	1,277,571	2.4	283,835	5.1	267,598	5.81
1891	1,247,750	4.	188,332	2.67	169,035	4.67
1890	1,199,807	1.88	148,827	1.61	115,319	4.32
1889	1,098,602	....	128,159	....	80,510	....

In respect to the kinds of train brakes in use there seems to be but little approach toward uniformity. In fact the claim that the adoption of uniform safety devices both brakes and couplers, is progressing with satisfactory rapidity is not borne out by the tables given in the report. There is little use in discussing this point now, however, since recent legislation has settled the question in as far as automatic couplers are concerned. To show the principal types of train brakes in use we have compiled the following table from the reports of 1891 and 1890:

	Total nmmber 1891.	1890.
American steam	1,528	1,762
Baldwin	4	12
Beal's steam	6	....
Boyden	184	86
Eames' vacuum	1,018	1,578
Gardiner & Ransom	13	....
Lansberg	6	6
Lawrence vacuum	10	....
Longbridge	1,070	1,111
New York	284	....
Standard empire vacuum	18	18
Westinghouse	178,492	144,085
Salisbury steam	....	8
Unclassified	5,800	610

TABLE II.—Showing Number of Each Class of Employees per 100 Miles in Each Group of States.

Class.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	U. S.
General officers	7	7	4	3	3	2	2	2	3	2	3
Gen. office clerks	18	29	18	10	11	12	12	12	15	10	15
Station agents	30	29	21	15	13	15	12	12	9	7	16
Other stationmen	100	103	63	32	26	30	11	24	24	17	42
Enginemen	35	50	29	15	14	17	14	15	12	10	21
Firemen	38	50	29	16	16	18	16	17	12	10	22
Conductors	28	35	21	11	9	12	11	9	8	7	15
Other trainmen	86	118	51	31	24	26	14	23	18	13	40
Machinists	24	51	20	9	10	13	9	10	11	6	17
Carpenters	44	60	28	16	19	17	14	11	18	11	23
Other shopmen	42	117	62	31	41	47	51	33	35	37	52
Section foremen	23	25	20	14	13	18	21	15	13	9	17
Other trackmen	156	200	105	97	94	71	71	87	104	70	102
Switch, flag and watch men	56	67	37	16	14	19	10	13	11	6	25
Tel. operators and train dispatchers	12	29	19	11	7	11	7	10	8	4	12
On floating equipment	3	11	2	3	6	1	...	5	3	4	4
All other	107	160	71	67	25	37	40	42	29	19	60
Totals	809	1,141	600	397	345	366	315	340	333	242	486

The statistics of automatic couplers are presented in a very inconvenient form, no attempt being made to divide them so as to show the M. C. B. and link-and-pin types separately. This we have done in the following table, also separating the Miller and Janney-Miller, practically all of which are on passenger cars and locomotives, from the others:

Coupler.	Cars equipped 1891.	1890.
M. C. B. Couplers.		
Dowling	6,340	2,021
Fox	100	3
Gould	26,746	10,807
Hinson	5,227	1,900
Janney	52,975	36,615
Keystone	10	10
"M. C. B"	8,813	10,756
Schroyer	18	18
Standard	1,006	356
Thurmond	5,006	3,041
Timms	1,207	750
Van Dorsten	8,227	2
Trojan	276	......
Buckeye	304	......
Total	116,255	66,279
Link and Pin.		
Aikman	119	264
Almy	133	......
Ames	3,909	10,413
Blackstone	132	132
Blocker	1,516	1,379
Colby	78	92
Cook	.....	.....
Cowell	183	174
Hein	170	212
Hilliard	2	2
Huselton	2,049	1,342
Kling	226	14
Lancaster	....	......
Lorraine	110	10
McCree	313	313
McKeen	97	194
Marks	2,097	1,963
Mills	550	1,037
Perry	140	9
Phillips	19	22
Runkle	....	......
Safford	2,962	1,981
Skinner	17	10
Smillie	6,893	5,440
Smith	....	......
Sweet	....	......
United States	235	418
Whittemore	84	84
Wilson	....	......
Wils'n-Blo'k'r	....	51
Total	20,042	25,556
Passenger Couplers.		
Miller	21,354	19,879
Janney-Miller	392	68
Total	21,746	19,947
Unknown and unclassified.		
American	720	......
Eastwick	6	......
Mather	740	......
Richardson	20	......
Union	160	......
Williams	102	......
Wilkins	28	......
Kind not known	5,871	3,537
Total	7,647	3,537

The most significant fact in this table is the general decrease in the number of cars equipped with the link-and-pin coupler. The figures show a decrease of 5,514 cars equipped with link-and-pin couplers and an increase of 51,775 cars, including passenger, equipped with the M. C. B. type.

TABLE III.—Showing Relative Efficiency of Railway Employees in the Different Groups.

Group.	Enginemen. Pass.-miles. 1=1,000.	Enginemen. Ton-miles. 1=1,000.	Firemen. Pass.-miles. 1=1,000.	Firemen. Ton-miles. 1=1,000.	Conductors. Pass.-miles. 1=1,000.	Conductors. Ton-miles. 1=1,000.	Other trainmen. Pass.-miles. 1=1,000.	Other trainmen. Ton-miles. 1=1,000.
I.	746	1,080	694	1,005	929	1,347	306	444
II.	395	2,790	393	2,777	560	3,957	165	1,172
III.	313	2,703	308	2,658	423	3,655	176	1,519
IV.	292	2,139	271	1,986	420	3,076	141	1,033
V.	292	2,117	274	1,982	459	3,323	181	1,309
VI.	314	2,461	300	2,350	445	3,489	208	1,633
VII.	294	1,671	271	1,[illegible]50	383	2,187	292	1,667
VIII.	257	1,628	227	1,440	418	2,645	170	1,077
IX.	297	1,889	291	1,848	438	2,783	196	1,244
X.	736	2,326	720	2,274	1,005	3,490	551	1,739
U. S.	369	2,329	354	2,235	524	3,306	199	1,256

Employees.—The total number of men employed by the railway companies of the United States, according to the commission's report, was 784,285, an increase of 34,984 or 728 men for each 100 miles of new line brought into operation. As indicating the relation in which the business of transportation stands to the industries of the country at large it is interesting to note that the population of the country increases at a less rapid rate than that portion of the population engaged in transportation by rail. On the assumption that the annual increase in population is 1,250,000 the increase noted has been as follows:

	No. of inhabitants. 1891.	1890.	1889.
One employee to	82	84	87

In the year covered by the report the proportion of inhabitants to one employee by groups of states was as follows:

Group.	No. employees.	No. inhabitants.	Group.	No. employees.	No. inhabitants.
I.	1	89	VI.	1	75
II.	1	67	VII.	1	49
III.	1	68	VIII.	1	73
IV.	1	129	IX.	1	96
V.	1	159	X.	1	86

Speaking generally this table reflects three classes of conditions: The first of these is found in Groups I. II. and III., which are characterized by a dense population well supplied with railway facilities. The number of inhabitants for one railway employee is 89, 67 and 68, respectively. That relatively fewer persons are engaged in the business of transportation in Group I. than in either Group II. or Group III. is probably due to the fact that no considerable portion of freight designed for export passes through the New England States. The second class of conditions is found in the Southern States, that is, in groups IV., V. and IX., where it will be observed the ratio of the population to one person engaged in the railway service is as 1 to 129, 159 and 96, respectively. The states comprising these groups are characterized by a fairly dense population poorly equipped with railway facilities and, consequently, the railway industry makes a comparatively slight demand on the labor of the people. The third class of conditions is found in groups VII. and X., which are characterized by a sparse population well equipped with railway facilities. The roads in this group live largely on through freight and expectations of future development, and the proportion of the total population in their employ throws no light on the normal ratio of the business of transportation to other industries in a normally developed community.

Table II. shows the number of employees of each class per 100 miles of line in each group of states, and the average for the whole country. Assuming that the number of sections is the same as the number of section foremen we have calculated the length of track section and the average number of men in a section gang as follows:

Group.	Av. length track section, miles.	Av. No. in section gang.	Group.	Av. length track section, miles.	Av. No. in section gang.
I.	4.35	7.79	VII.	4.77	4.4
II.	4	9	VIII.	6.67	6.8
III.	5	5.25	IX.	7.7	9
IV.	7.15	7.93	X.	11.1	8.7
V.	7.7	8.23	U. S.	5.89	7
VI.	5.55	4.9			

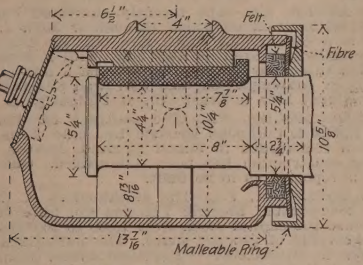
Of course, the difference in the number of employees per 100 miles for the different sections, as shown in Table II., indexes the density of the traffic and not the relative efficiency of the men. This is clearly shown in Table III., showing the number of ton-miles and passenger-miles which are made per employee of each class. As will be noticed, that while more men are employed where the traffic is dense, each man performs more useful work than in the sections where traffic is light. The reason for this is easily found in the heavier train-loads in the sections where the traffic is dense.

The remaining matter in the commission's report and the manual covering in general the capitalization, earnings and expenses, fixed charges and accidents is postponed until our next issue.

THE ADAMS OIL BOX.

The ingenuity of many inventors has been exercised upon the designing of an axle box which will prevent the great waste of oil by leakage at the back of the box. The amount of oil thus wasted is little realized, but even the most casual observer must have noticed the oil-soaked appearance of ties in the track, and of both ties and soil in busy yards. We illustrate this week a form of box which appears to possess some excellent features in this respect, and very satisfactory results are reported for the experience of it in service, a saving of one-third of the ordinary amount of oil used being claimed for it.

The form of the box is shown on the cut, and differs from the regular M. C. B. standard box only in having a collar at the back 1⅛ ins. deep. A cast malleable iron box ring is shrunk on the axle against the wheel. Against this is a washer made of fiber, which fits snugly around the axle and against the back of the box ring, acting as a packing to exclude dust and foreign matter. Fitted inside the collar of the box is a hard felt ring 1 in. thick, which fits up against the fiber washer. This box is one of the specialties of the Standard Railway Equipment Co., 24 Whitehall St., New York. The following is a communication sent to this company by the Boston & Albany R. R.:

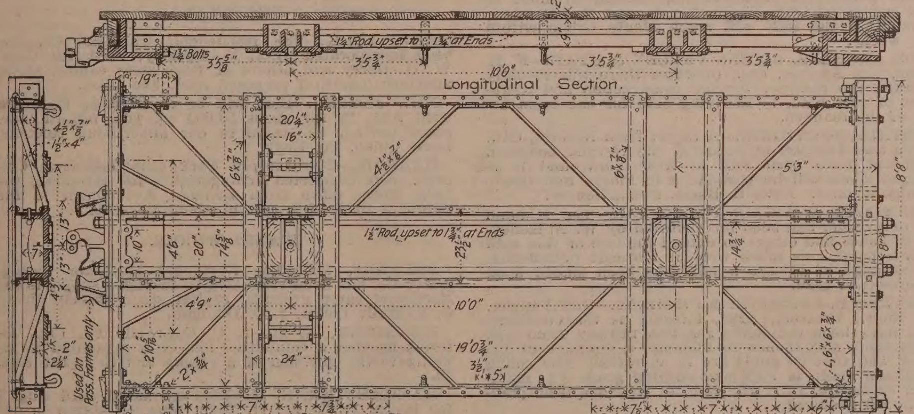


Section of Adams Oil Box.

> We have these boxes under about 1,000 cars, more or less, and consider them a success, particularly in excluding dust and grit, thereby saving the wear on both brass and journal. There is plenty of evidence here that can be seen by anyone so desiring, to show that the journal bearings make from 130,000 to 175,000 miles. Our passenger cars are now, most of them, fitted with this box, and, as we are very particular in keeping the mileage of our wheels and brasses under all of our passenger equipment, we can, with certainty, say what amount of service we get from the various kinds in use. This box, at least, doubles the life of the journal brasses.

STANDARD IRON TENDER FRAME; RICHMOND & DANVILLE R. R.

We illustrate in the accompanying cut the standard iron tender frame which has been used on the Richmond & Danville R. R. for some time, with very good results. The construction of the frame is so clearly shown in the illustration that it requires but little description. It will be noted, however, that the frame has two 1½-in. rods, upset to 1¾ ins. at the ends, that extend its entire length, and are secured to both end pieces. In addition to these rods the coupler at the rear is fastened by two 1¾-in. bolts secured to the end casting. At the front end the two through bolts or rods take the friction casting between the engine and tender, while the drawbar is fastened to a casting bolted firmly to the main channel iron, and two bolts are not depended upon for holding all the strain of pulling the load. The further details of the frame will be seen from the drawing. This frame costs complete, including wooden flooring fastened down, $210. We are indebted to Mr. T. W. Gentry, Master Mechanic, Richmond & Danville R. R., for the matter from which the illustration has been prepared.



STANDARD IRON TENDER FRAME; RICHMOND & DANVILLE R. R.

The coal consumption in warships, says Mr. Riley, an engineer of the English Navy, in a late paper read before the Royal United Service Institute, has been reduced about 20% by the introduction of the triple expansion engine as compared with the compound engine; compared with the simple engine the reduction is about 50%. Mr. Riley claims that the efficiency of the triple-expansion engine is satisfactory over a wide range of power, and to prove this he gives the following data: A modern battle-ship, steaming at a little over 13 knots, will consume coal at the rate of 2 knots per ton of coal; at 11 knots, it is 3.7 knots per ton of coal, and at 6.77 knots the coal consumption drops to 7½ knots per ton, or 21.6 tons per day.

The area of cultivated, or irrigated land in lower Egypt was 5,704,808 acres, or 8,914 sq. miles, in 1891, according to the latest report of Lieut.-Col. Justin C. Ross, C. M. G., Inspector-General of Irrigation in Egypt. The total expended for 1891 on earthworks, masonry and pile protection was $2,444,640. The surveying staff is at work upon the location of large storage reservoirs in upper Egypt, with a view to their future construction. This staff has triangulated and surveyed upward of 800,000 acres of irrigated land in lower Egypt.

"The eighth wonder of the world," said Mr. Andrew Carnegie in a recent interview, "is this: Two lbs. of ironstone purchased on the shores of Lake Superior and transported to Pittsburg; 2 lbs. of coal mined in Connellsville and manufactured into 1¼ lbs. of coke and brougth to Pittsburg; ½ lb. of limestone mined east of the Alleghenies and brought to Pittsburg; a little manganese ore mined in Virginia and brought to Pittsburg, and these 4½ lbs. of material manufactured into 1 lb. of solid steel are sold for 1 cent."

The first whaleback steamer built in Great Britain was launched on June 15, from the yards of William Doxford & Sons, Limited, Sunderland. Her principal dimensions are 320 ft. × 38 ft. 2 in. × 26 ft.; load draught, 19 ft.; and she is intended to carry about 3,500 tons. She is fitted with triple-expansion engines. The cylinders are 23 ins., 37 ins. and 60 ins. in diam. by 42-in. stroke, and steam is supplied from large single-ended boilers. The hull generally is of the whaleback design, and above this are erected seven towers, forming supports on which are carried the winches, derricks, cabins, etc., the two towers over the machinery space being much larger than the others, and upon them and around the engine and boiler openings are built the whole of the cabins, which are seven ft. above the hull proper, and are supported at the sides by large ventilating tubes which are carried down through the decks and into the engine and boiler room. The vessel has nine cargo hatchways, and, as usual in whaleback steamers, these are built without coamings, and are fitted with watertight iron covers which are bolted down, leaving the whole of the upper portion of the vessel clear of obstructions other than the towers already referred to.

The Commissioners of Sewerage for the Tenth, Fifteenth and Twentieth Wards in the city of Rochester, N. Y., and the town of Gates invite bids until Aug. 21 for 17,700 lin. ft. of brick sewer, 5 ft. to 9 ft. 3 ins. in diameter, including 1,980 lin. ft. of tunnel. Full particulars will be published in our advertising columns next week.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

ALTOONA & PHILIPSBURG CONNECTING.—W. T. Forsythe, Ch. Engr. and Gen. Man., informs us that 11 miles of this road have been graded, 1½ miles partially graded and 8 miles additional under contract. About three miles of track have been laid and it is hoped to have the road opened for traffic by Sept. 1. The entire route of the road, 20 miles, is through the coalfields of Pennsylvania, extending from Philipsburg through Osceola Mills, Houtzdale and other towns in Clearfield Co. E. A. Tennis, contractor, Thompsontown, Pa.

BALTIMORE & OHIO.—This road is to be reballasted between Pittsburg and Cumberland.——W. A. Smith, Zanesville, O., Asst. Ch. Engr., Snow Fork & Hocking R. R., informs us that about two-thirds of the right of way has been obtained for this road, which is proposed from the end of the Rock Run extension near Shawnee, O., through Murray, Buchtel, Doanville, Floodwood, and terminating for the present at Chauncey, Athens Co., O. The proposed terminal, when completed, is at Athens, and the total length is 18.6 miles. There will be two tunnels, but no large bridges.——The Cleveland, Wooster & Muskingum Valley R. R. has filed articles for extending its line so that its northern terminus will be at Cleveland instead of Lodi, and its southern terminus at Zanesville instead of Wooster; also for a branch from the new line, in Holmes Co., through Coshocton and Guernsey counties to Cambridge, Ohio.

CENTRAL R. R. OF NEW JERSEY.—Surveys are being made near Perth Amboy for a branch two miles long to pottery works.

KINGFIELD & DEAD RIVER.—McGregor Bros., Rumford Falls, Me., have commenced work on ten miles of this road from Kingfield, Me., the terminus of the Franklin & Megantic road, north to Drews Mills. Two streams, each about 140 ft. wide, are to be crossed and the entire distance is through a broken country. A. F. Hilton, Ch. Engr., Kingfield, Me.

LAKE ERIE & WESTERN.—It is reported that the extension of this road from Minster to Piqua, O., a distance of 25 miles, will probably be commenced at an early date. T. H. Perry, Ch. Engr., Indianapolis.

LONG ISLAND.—The state board of railroad commissioners has granted permission for the construction of the Montauk Extension road, recently described in these columns.

MICHIGAN CENTRAL.—The Midland branch of this railway is to be extended 14 miles to Hubbard, Mich., to open up large pine tracts, according to reports.

MONTREAL & WESTERN.—G. H. Garden, Ch. Engr., St. Jovite, Que., informs us that this road will probably be opened for traffic this month. It extends from St. Jerome northwardly toward Le Desert, Que., a distance of 70 miles. The road crosses the Laurentian Mts., 75 miles from Montreal and 1,425 ft. above the St. Lawrence River.

OTTAWA & GATINEAU VALLEY.—We are informed by W. Dale Harris, Ch. Engr., Central Chambers, Ottawa, Ont., that this road has been surveyed from Ottawa to River Desert, in Maniwaki, about 83 miles; 45 miles are in operation, and 10 miles well advanced in construction, upon which tracklaying will soon be commenced. The maximum curvature is 10° and maximum grade 2%. The first 37 miles follows the windings of the Gatineau River and the remaining route keeps 2 to 6 miles away from the river. There are no large bridges and the work is being done by day labor.

PENNSYLVANIA.—The Cresheim branch of the Philadelphia, Germantown & Chestnut Hill, known as the Fort Washington branch, has been completed and opened for traffic. It extends from Cresheim Junction, Pa., north to Fort Hill, on the Trenton Cut-off, 5.87 miles.

SINNEMAHONING VALLEY.—This road is expected to be completed from Costello to Galeton, Pa., a distance of 35 miles, in October. A branch is also being built from the main line at Keating, Pa., down Kettle Creek to Cross Fork, 13 miles, 70-lb. steel rails being used. With the opening of the road to Galeton the name will be changed to the Buffalo & Susquehanna, according to reports.

SOUTH MOUNTAIN.—A report from Reading, Pa., states that this road is progressing rapidly in the vicinity of West Reading. The grading has been finished to Fulton's Ferry, near the Lebanon Valley R. R. bridge. It is proposed to complete the line to Harrisburg first. Jas. Marsh and Jas. Clark are the contractors.

TOLEDO & SOUTH SHORE.—This road will be extended from Lawton to Marcellus, Mich., to connect with the Grand Trunk, according to reports.

WABASH.—It is reported that a branch will be built from Butler to Ft. Wayne, Ind., to connect the Detroit-Chicago line with the main line.

WASHINGTON, WEST SHORE, BALTIMORE & DRUM POINT.—This company has purchased the unfinished Drum Point road and will at once complete it to tidewater at a cost of about $620,000. A bayside town will be established at Plum Point, 35 miles from Washington and 55 miles from Baltimore. Drum Point Harbor has more than 10 miles of deep-water front, and it is proposed to make this a coal-shipping point. The road will connect with the Baltimore & Potomac division of the Pennsylvania, which company is believed to be interested in the new deep-water terminal scheme. Pres., T. H. Martin; Gen. Man., J. H. McCreery; Ch Engr, D J. Howell, all of Washington.

Projects and Surveys.

BOSTON & NOVA SCOTIA COAL.—The Boston & Nova Scotia Coal Co. has awarded to Garson, Purcell & Co., of St. Catherines, Ont., the contract for the construction and equipping its whole line of 35 miles of railway from Broad Cove to Orangedale, N. S.

COLLINGWOOD & TORONTO AIR LINE.—This road is proposed from Collingwood to Toronto, Ont., a distance of about 70 miles. At Collingwood, on Nottawasaga Bay, movable elevators would be used, to be worked probably by storage batteries, according to the prospectus. The rails to be used will be 100 or 120-lb., and the estimated cost of the road, including equipment and terminals, is $2,330,000. Frank Moberly, Chief Engineer.

DEER CREEK.—The subscription books have been opened for this road, recently noted as incorporated to build a railway between Belair, Md., and the Susquehanna River, near Havre de Grace.

DOMINION COAL CO.—McDonald & McManus, Moncton, N. B., are reported to have been awarded a contract for ten miles of railway from the colliery at Glace Bay, through Cow Bay and toward Louisburg, in Cape Breton.

ESCANABA WESTERN.—Incorporated in Michigan to build a railway from Escanaba, Mich., to connect with the Minneapolis, St. Paul & Sault Ste. Marie and Chicago, Milwaukee & St. Paul; capital stock, $100,000. It is reported that Remington & Co. will construct the road.

INDIANA.—It is proposed to construct a railway from Beeson's Station, near Cambridge City, Ind., on the Lake Erie & Western, through Richmond to Manchester, O., to connect with the Cincinnati, Jackson & Mackinaw.

LAKE HOPATCONG, BOONTON, MORRISTOWN, CALDWELL & NEW YORK.—H. C. Raynolds, Secy., Whippany, N. J., informs us that surveys have been completed and the right of way secured for this road in New Jersey to extend from Essex Falls through Troy Hills, Parsippany and Rockaway, a distance of 15 miles, where it will connect with the Central R. R. of New Jersey for Lake Hopatcong. A branch five miles long will extend from Troy Hills to Whippany and Morristown, and a branch two miles long from Parsippany to Boonton. A tunnel is projected near Montclair, by which the route is shortened about five miles.

NEW YORK, NEW ENGLAND & NORTHERN.—This company, noted last week as incorporated, has elected A. A. McLeod president; W. K. Niver, vice-president; and H. G. Odenheimer, secretary. It is reported that Ryan & McDonald, Baltimore, will build the proposed road.

OHIO.—Jas. G. Marshall, New Cumberland, O., is making surveys for a narrow gage railway up Hardin's Run to the Herron coalfields, upon which the construction will soon be commenced, according to reports.

Southern.—Existing Roads.

ATLANTIC, SUWANNEE RIVER & GULF.—About 65 miles of this road have been surveyed and 7½ miles of track laid from Starke to Sampson, Fla. The road is projected to extend from Jacksonville, Fla., through Bradford, Alachua and Lafayette to Deadman's Bay, on the Gulf of Mexico, a distance of 100 miles.

HARRIMAN COAL AND IRON.—It is reported that two miles of track have been laid north from De Armond, Tenn. J. A. Farleigh, Ch. Engr., Harriman, Tenn.

NASHVILLE & KNOXVILLE.—The tracklaying on this road has reached Thorn Gap, 13 miles from Cookeville, Tenn.

SEABOARD AIR LINE.—It is reported that a branch will be built from the Raleigh & Gaston to Ralesville, N. C., a distance of five miles, to reach extensive granite fields. W. W. Gwathmey, Ch. Engr., Portsmouth, Va.

WILMINGTON, NEW BERNE & NORFOLK.—This road is completed and in operation from Wilmington, N. C., to Pallacksville, N. C., a distance of 75 miles, and the grading has been finished between Pallacksville and New Berne, a distance of 10 miles. It is expected to have the road in operation to New Berne, N. C., by the middle of this month.

Projects and Surveys.

CHEAT RIVER.—Incorporated in West Virginia to build a railway, about 20 miles long, from near the mouth of the Cheat River, connecting with the Baltimore & Ohio and the Pennsylvania roads, to Rowlesburg, W. Va., on the headwaters of the Cheat River, connecting again with the Baltimore & Ohio. Emmet Green and Geo. Heard, Pittsburg, Pa., are interested.

GREYSTONE GRANITE.—This company is reported as about to construct a railway from Forestville to granite quarries at Rolesville, N. C., a distance of five miles.

UNAKA & NOLACHUCKY.—J. L. Cain, Vice-Pres., is reported as stating that the location of this road in Tennessee has been completed and that the construction will probably be commenced within 30 days. R. A. Bowie, Ch. Engr., Greeneville, Tenn.

Northwest—Existing Roads.

MANISTEE & NORTHEASTERN.—Surveys are being made for an extension of this road in Leelanaw Co., Mich., to open up the territory tributary to Glenn Haven, Glenn Arbor, Empire, Leland, Good Harbor, Burdickville and Maple City. J. J. Hubbell, Ch. Engr., Manistee, Mich.

SIOUX FALLS, YANKTON & SOUTHEASTERN.—The grading and bridge buiding have been completed on this road between Sioux Falls and Yankton, S. Dak., and the tracklaying commenced at Sioux Falls. The grading west of the Missouri River is half completed to Norfolk, Neb. The road is reported as purchased by J. J. Hill, and when finished it will be an extension of the Great Northern and will connect with the Missouri Pacific.

Projects and Surveys.

DUQUOIN & MURPHYSBORO COAL.—Walter S. Hawkes, Ch. Engr., Duquoin, Ill., informs us that this proposed road in Illinois will be about 20 miles in length, of which four miles have been located. It is hoped to commence the construction in September.

TERRE HAUTE, SAYLOR SPRINGS & MOUNT VERNON.—Incorporated in Illinois to construct a railway from the Wabash River, near York, Clack Co., to Mount Vernon, Jefferson Co., Ill.; capital stock, $2,000,000; L. W. Barnes and B. F. Scaife, Saylor Springs; Geo. W. Evans, Mount Vernon; C. E. Hilts, St. Louis; C. B. Cole, Chester.

Southwest.—Existing Roads.

GALVESTON & WESTERN.—According to press reports, a construction company is being formed with a capital stock of $500,000 to build the proposed extension of this road. One-half of the stock will be subscribed by local capitalists, and it is expected to place the remainder in New York. As soon as the financial situation becomes settled the eastern extension of the road, by way of Bolivar Point to the Sabine River, will be begun and pushed through as rapidly as possible. Cars are to be transferred across Bolivar Channel, separating Galveston from the eastern shore, by means of ferryboats.

GREENFIELD & NORTHERN.—The extension of this railway in Missouri has been located from Greenfield to Arcola, 12 miles north, and the construction will be commenced this month. T. A. Miller, Gen. Man., Aurora, Mo.

GULF, BEAUMONT & KANSAS CITY.—The stockholders of this road, described in our issue of July 20, have decided to issue bonds to the amount of $10,000 per mile.

HUTCHINSON & SOUTHERN.—Surveyors have been at work for some weeks in the Cherokee strip permanently locating the lines for the extension of the railway into Oklahoma, and work was commenced July 24 at Cameron, Kan., to push the road further south. The road has been in operation from Hutchinson to Cameron on the state line for several years, and they hope to get an extension built to Pond Creek, I. T., before the opening of the strip and will then build straight from there to Guthrie and on to Texas. E. E. Wise, Gen. Man., Chicago.

TEXAS CENTRAL.—This company has filed a mortgage of $2,000,000 to make improvements and extensions.

TEXAS MIDLAND.—Bonds are to be issued for $900,000, of which $150,000 will be first mortgage betterment bonds and $750,000 second mortgage purchase and extension bonds. The extensions proposed are from Roberts to Greenville, and from Greenville to Waco, all in Texas.

Projects and Surveys.

SPRINGFIELD & SEDALIA.—The Springfield & Sedalia Construction Co. has been incorporated in Missouri by John T. Robbins, M. J. Shelley and Richard Dunsford; capital stock, $50,000. It is reported that the company is incorporated to build the proposed railway between Springfield and Sedalia in that state. The plans include the purchase of the Sedalia, Warsaw & Southern, a narrow gage road from Sedalia to Warsaw, referred to last week. This road will be changed to standard gage and a new road built from Warsaw to Springfield. Work is expected to be commenced in October.

TEXAS.—It is reported that McSweeney Bros. have been awarded the contract for constructing a railway about 8 miles long from the sugar plantation of Cunningham & Miller, at Sugar Land, Fort Bend Co., to Arcola Junction, Tex., where it will connect with the International & Great Northern and the Gulf, Colorado & Santa Fe. The contract calls for grading, bridging and tracklaying, and the work is to be completed by Nov. 4.

TEXAS & GULF.—L. W. Lloyd, Marshall, Tex., has returned from New York where he has been in the interest of this proposed railway between Marshall and Sabine Pass, a distance of about 200 miles. He is reported as stating that a construction company is about to be incorporated with a capital stock of $500,000 to build the road and that the first 60 miles will probably be completed in six months, the contracts for this having been awarded to W. L. Bennett. A contract has also been awarded for 3,600 tons of 70-lb. rails.

Rocky Mt. and Pacific—Existing Roads.

BUTTE, ANACONDA & PACIFIC.—This company has sold $3,000,000 of bonds and is pushing the construction of the road as rapidly as possible. The line has been graded from Butte to Anaconda, Mont., about 25 miles, and preliminary surveys have been made beyond Anaconda for a distance of about 100 miles.

DENVER & RIO GRANDE.—The extension of this road from Crested Butte, Colo., to Anthracite Coal mines, 10.76 miles, will be completed next month. The grading is about finished and the bridge building will be done by Aug. 15. There will be about two miles of side tracks.

EVERETT & MONTE CRISTO.—It is reported that track has been laid on this road in Washington to within 7 miles of Monte Cristo, making 36 miles of road completed from Hartford east, and that it is expected that the rails will reach Monte Cristo within four weeks.

LOS ANGELES, OWENS VALLEY & UTAH.—F. E. Green, Los Angeles, Cal., to whom there was recently awarded the contract for the construction and equipment of this road, is receiving bids for the construction of the roadbed.

NEVADA SOUTHERN.—A report from Needles, Cal., states that $450,000 of bonds of the Nevada Southern extension have been sold in New York, and it is thought work will be pushed on to Pioche and Goode Springs at once. Isaac E. Blake, Pres., Denver.

PRESCOTT & ARIZONA CENTRAL.—The Midland Ry. of Arizona has been incorporated by W. N. Kelley, W. B. Jones and others to extend the line of this road from a point nine miles west of Prescott to Phoenix. A mortgage of $15,000 a mile has been placed upon the proposed road.

SANTA FE, PRESCOTT & PHOENIX.—G. W. Vaughn, Ch. Engr., Prescott, Ariz., informs us that the surveys have been completed for this railway from Ash to Prescott and thence to Phoenix, a distance of 196 miles, and that 60 miles are in operation. The ruling maximum grade is 1½% and pushing grade 3%; maximum curvature, 12°. The right of way has been practically all acquired.

Projects and Surveys.

CONSTRUCTION CO. & CENTER BEARING RY.—Organized at Portland, Ore., to "build a standard gage roadbed, with center elevated rail; to engage the bicycle system of locomotive and cars, from Portland to Mount Hood and intervening points; also to haul freight without change of cars to and from any part of the country."

Foreign.

MEXICO.—It is reported that all arrangements are now complete for the construction of the proposed railway between the city of Guadalajara and Chamala, a port on the Pacific coast. The concessionnaies say that the depreciation of silver will not interfere with the enterprise. The road will pass through a fine agricultural and mining country.

STREET RAILWAYS.

TEWKSBURY, MASS.—The Lowell & Suburban St. Ry. Co. has petitioned for authority to construct an electric railway through Tewksbury Centre and North Tewksbury and back to Lowell through Belvidere.

WAKEFIELD, MASS.—The Wakefield & Stoneham Electric St. Ry. Co. has voted to increase its capital stock from $50,000 to $150,000. The line will soon be extended to Lynn, a distance of five miles.

DANSVILLE, N. Y.—The Dansville Electric Ry. Co. has been granted a franchise.

STILLWATER, N. Y.—The Stillwater & Mechanicville R. R. Co. has been granted permission to increase its capital stock from $40,000 to $260,000.

ORANGE, N. J.—It is reported that the Suburban Traction Co. will soon award contracts for equipping its lines with the trolley system.

BANGOR, PA.—The contract for building the Pen Argyl, Bangor & Water Gap Electric Ry. has been awarded to Davis & Ludwig, New York. Work is to be commenced at East Bangor and pushed westward to Wind Gap, the contract calling for the completion of the line as far as Pen Argyl by Oct. 1, and that part of the line will then be put in operation. The company has decided to locate its power plant, etc., in this city.

LANCASTER, PA.—The recently chartered Pennsylvania Traction Co., of which ex-Senator John J. Patterson is president and which now controls the entire electric railway system of this city, with a branch to Columbia in course of construction, and a line to Philadelphia in contemplation, has borrowed $700,000 from the Provident Life & Trust Co., of Philadelphia.

M'KEE'S ROCKS, PA.—The contract for the McKee's Rocks & Corapolis Electric Ry., nine miles long, has been re-awarded to Simon Harrold, Beaver Falls, and the construction has been commenced. One large bridge is reported as to be built.

PHILADELPHIA, PA.—The stockholders of the recently incorporated Electric Traction Co. have decided to increase the capital stock from 1,000 to 50,000 shares at a par value of $50 per share. The authorized capitalization is $10,000,000.——The Hestonville, Mantua & Fairmount Passenger Ry. Co. has decided to use the trolley system. A power house will be constructed and engines to develop 5,000 HP. will be purchased, according to reports. The line of the Second & Third Streets Passenger Ry. Co. will soon be changed to the trolley system.

PITTSBURG, PA.—The Citizens' Inclined Plane Co. has given notice of intended application for a charter to construct the proposed Mt. Washington incline. J. A. McCormick, one of the promoters, is reported as stating that $53,000 worth of stock has already been subscribed. The estimated expense is $150,000.

TYRONE, PA.—The Tyrone Electric Ry. Co., noted July 13 as incorporated, has been granted a franchise. Construction must be commenced within nine months and at least part of the road be in operation within 18 months.

BALTIMORE, MD.—The Baltimore, Middle River & Sparrow's Point R. R. Co. has petitioned the county commissioners for a franchise for a street railway from the eastern limits of the city to Sparrow's Point, to be operated by electricity or other motive power than steam or horses. It is reported that the necessary money for the construction has been secured and that $100,000 will be spent for terminal facilities. Capital stock, $400,000; Thos. B. Gatch, L. F. Morris, F. W. Trimble, J. J. Forrester.

COLUMBUS, O.—Bids are asked until Aug. 17 for the construction and operation of a street railway on West Mound St., from High St. to the village of Harrisburg. John M. Doane, Cy. Clk.

DES MOINES, IA.—The Des Moines City Ry. Co. has been organized as a consolidation of the different street railway companies of this city; capital stock, $3,000,000; Pres., J. S. Polk; Treas., E. M. Hunter; Gen. Man., G. B. Hipfee.

BRANTFORD, ONT.—The Brantford Electric St. Ry. Co. is contemplating an extension of its line to Terrace Hill and Grandview, according to reports.

HIGHWAYS.

NEW YORK.—The Irondequoit Turnpike Co. has been incorporated by J. M. Beckley, Frederick Cook, W. C. Barry and others of Rochester; capital stock, $150,000; length of proposed road, five miles.

NEW JERSEY.—Bids will be received at Elizabeth until Aug. 22 for about 50,000 sq. yds. telford macadam paving, as stated in our advertising columns. Louis Quien, Co. Engr.

ILLINOIS.—The Lincoln Park Commissioners, Chicago, have completed arrangements for extending the Lake Shore drive from Belmont Ave. north to the Sheridan road, at a cost of about $300,000.

WATER-WORKS.

BELFAST, ME.—The Northport Mountain Springwater Co. has been organized to furnish a supply to the Northport camp grounds; capital stock, $8,000; Pres., C. E. Hall; Treas., J. C. Dunham.

HENNIKER, N. H.—J. C. Cogswell, Tn. Clk., informs us that a committee has been appointed to investigate the question of a supply and to report Aug. 19.

MANCHESTER, N. H.—Bids are asked until Aug. 7 for laying 11,950 lin. ft. 20-in. pipe, as stated in our advertising columns. Geo. E. Evans, Engr.

BRANDON, VT.—The citizens have voted $4,600 for an additional main.

LYNDONVILLE, VT.—Several plans are proposed for a supply.

NEWPORT, VT.—The proposed supply from Derby Pond is estimated to cost $17,000.

NORTHFIELD, VT.—Work will soon be commenced on a new reservoir.

NORWICH, VT.—The Norwich Water Supply Co. has been incorporated to secure a supply; capital stock, $3,000.

ATTLEBORO, MASS.—The committee has reported on a supply from Orr's Pond, where a new dam is proposed; estimated cost, $18,000.

BLANDFORD, MASS.—An artesian supply is being secured.

FOXBORO, MASS.—Wm. Lamphier is interested in securing a supply for West Foxboro and Lakeview. Surveys are proposed.

HOLYOKE, MASS.—A supply is proposed from Granville Brook; estimated cost, $225,000.

MELROSE, MASS.—The board has voted to make a test of the wells at Whittier's Springs for an additional supply.

METHUEN, MASS.—Jos. S. Howe, Tn. Clk., informs us that the town has voted to construct works at an estimated cost of $150,000. The supply will probably be from driven wells and pumped to a reservoir. Edwin J. Castle, Chn. Bd.

WEST BOYLSTON, MASS.—The committee, appointed in March, 1892, has reported in favor of a gravity system from a brook in Holden; estimated cost, $91,186.

ANSONIA, CONN.—The Ansonia Water Co. has decided to lay about a mile of 6-in. main with 4-in. mains in side streets, according to reports.

EAST HARTFORD, CONN.—The East Hartford Water Co. is about to make important extensions.

ANDOVER, N. Y.—H. C. Norris, Vil. Clk., informs us that a gravity supply is proposed from springs; estimated cost, $20,000. The contract for the construction will probably be awarded Aug. 17. Patrick Cannon, Chn. Bd.

COLD SPRING, N. Y.—The citizens have voted on the issue of bonds for $30,000 for works.

DOLGEVILLE, N. Y.—Frank K. Baxter, Engr., Utica, informs us that the contract has not yet been awarded for works, though it is reported that the construction will soon be commenced.

HAMBURG, N. Y.—The Water & Electric Light Co. has been incorporated by D. N. Lockwood, G. M. Pierce and others.

LOWVILLE, N. Y.—Surveys are being made for the proposed works.

MAMARONECK, N. Y.—Steps are being taken to purify the supply.

MOUNT KISCO, N. Y.—An election will be held Aug. 15 to vote on the question of works. A. L. Banks, Pres. Comrs.

ROSCOE, N. Y.—The contract for a supply has been awarded to W. H. Cowan, Montgomery.

ST. JOHNSVILLE, N. Y.—It is reported that contracts have been awarded as follows: Small & Galleo, Brooklyn, construction, $6,900; Jackson & Woodin Mfg. Co., Berwick, Pa., pipe, $12,548; R. D. Wood & Co., Philadelphia, valves and hydrants $1,775, and sundries $2,100. The total cost will be about $25,000.

SHERMAN, N. Y.—A private company is being organized to secure a supply.

TROY, N. Y.—Plans have been adopted by the commissioners for a gravity supply and Prof. Wm. G. Raymond engaged as chief engineer; estimated cost about $700,000.

WHITESBORO, N. Y.—Chas. C. Hopkins, Cy. Engr., Rome, has been engaged to make surveys for a supply.

BOONTON, N. J.—Geo. Fitzpatrick, Cy. Clk., informs us that the Boonton Water Co., of which Lewis Van Duyne is president, proposes to secure a gravity supply from mountain streams.

ALLEGHENY, PA.—Julian Kennedy has been engaged as consulting engineer on the proposed improvements.

JOHNSTOWN, PA.—Bids are asked until Aug. 7 for about two miles of trenching for the water main of the East Conemaugh and Franklin water-works. F. D. Confer, Secy.

NEW BLOOMFIELD, PA.—The New Bloomfield Water & Sewer Co. has been incorporated by Dr. A. R. Johnston, W. F. H. Garber and others to secure a supply; capital stock, $10,000.

PITTSBURG, PA.—It is reported that land is about to be purchased for a new reservoir.

SOMERSET, PA.—The council has voted to advertise for a gravity system of works.

PIEDMONT, W. VA.—Bonds for $37,000 for works will be sold Aug. 13.——Bids are asked until Aug. 20 for works, as stated in our advertising columns. Alexander Potter, Engr., New York.

FORSYTH, GA.—Plans have been accepted for works. There will be 3½ miles of mains; estimated cost, $20,000.

HAWKINSVILLE, GA.—The election to vote on the question of works has been postponed.

LUVERNE, ALA.—C. R. Bricken desires to correspond with water-works contractors.

TROY, ALA.—The contract for works has been awarded to Remington & Co., Chicago; estimated cost, $40,000 to $50,000.

BELLAIRE, O.—Bonds for $25,000 for improvements are advertised.

CINCINNATI, O.—Advertisements for bids for the Price Hill tank have been ordered.

GLENVILLE, O.—Bids are asked until Aug. 18 for 8 and 6-in. mains. W. J. Brack, Secy.

HAMILTON, O.—Extensions are proposed estimated to cost $150,000 to $200,000.

LINWOOD, O.—Bids are asked until Aug. 22 for pumping machinery, pipe, etc., as stated in our advertising columns. Geo. Hornung, Consult. Engr.

LOCKLAND, O.—Bids are asked until Aug. 22 for works. E. O. Buchanon, Vil. Clk.

LOGANSPORT, IND.—Bids are asked until Aug. 8 for a 3,000,000-gallon pump. E. C. Throckmorton, Clk. Bd.

MICHIGAN CITY, IND.—It is reported that 17 additional wells are being sunk.

BELDING, MICH.—The city is in the market for water-works and firemen's equipment. F. A. Palmer, Cy. Surv.

CARSONVILLE, MICH.—It is reported that works will soon be constructed.

KALAMAZOO, MICH.—About a mile of pipe will soon be laid.

CHICAGO, ILL.—The commissioner of public works will receive bids until Aug. 7 for special castings, hydrants and stop-valve castings.——The joint bid for pipe for the mains in West Pullman and Humboldt Park has been accepted at the prices published last week.

DANVILLE, ILL.—Plans for works have been prepared by J. M. Carson; estimated cost, $62,000.

HIGHLAND PARK, ILL.—The contract for works, except power outfit, has been awarded to Edmund T. Sykes, Minneapolis, at $46,395.

UPPER ALTON, ILL.—An election will be held Aug. 4 to vote on the extension of the mains to Piasa Bluffs.

WINONA, MINN.—The city engineer has prepared plans for a supply at Sugar Loaf; estimated cost, $5,160.

WAMEGO, KAN.—Works are being discussed.

BUFFALO, WYO.—W. P. Keays, acting mayor, informs us that bonds for $40,000 have been issued for works, for which the contract will probably be awarded about Sept. 1. A gravity system is proposed.

INDEPENDENCE, MO.—The Independence Water-Works Co. has voted to increase its capital stock from $150,000 to $212,300.

ST. LOUIS, MO.—The Crystal Water Co. has been incorporated by Chas. E. Pearce, Jas. Thomas and others; capital stock, $100,000.

BALLINGER, TEX.—Bids are asked until Aug. 8 for works. J. W. Powell, Mayor.

GOLIAD, TEX.—The Goliad Water & Light Co. has been incorporated by J. H. Ewell, R. R. Stout and others; capital stock, $30,000.

BALLARD, WASH.—The city council has voted in favor of issuing $60,000 of bonds for water, $40,000 for sewerage and $11,000 for electric light.

HOQUIAM, WASH.—The citizens have voted to issue bonds for $24,000 for a supply from Fry Creek, about a mile north of the town. Pumps will be used.

PUYALLUP, WASH.—Wm. M. Seeman, Cy. Clk., informs us that an election was called for Aug. 1 to vote on the issue of bonds for $60,000 for works.

SPOKANE, WASH.—The so-called Junken-Harrington water proposition has been carried by a vote of 1,300 to 300. The plans include a dam to develop 2,400 HP., two 4,000,000-gallon pumps and a force main estimated to cost $140,000; total cost, $307,000, not including reservoir and stand-pipe.

SUMNER, WASH.—L. R. Coombs, Tn. Clk., informs us that bids will be received until Aug. 23 for $17,000 of bonds for a gravity supply.

OREGON CITY, ORE.—The contract for a 1,000,000-gallon pump has been awarded to the Union Iron Works, Portland, at $5,620. Bids are asked for a reservoir, and will soon be asked for $10,000 of bonds.

PORTLAND, ORE.—Frank T. Dodge, Clk. Com., will receive bids until Aug. 10 for three reservoirs and until Aug. 15 for submerged pipe.——The city council has voted to purchase the plant of the East Portland Water Co., for $50,000.

PLACERVILLE, CAL.—The Placerville Water-Works Co. has been incorporated at San Francisco; capital stock, $120,000; Eliza Baum, R. W. Baum, John Peat and others.

SAN DIEGO, CAL.—A supply is proposed from Otay.

COWANSVILLE, QUE.—A. L. Husband has prepared plans for works; estimated cost, $24,000.

ARTESIAN WELLS.

DETROIT, MICH.—An artesian well is to be sunk at the County Insane Asylum, it is reported.

HUBBARD CITY, TEX.—It is stated that a well will be sunk.

IRRIGATION.

GREAT BEND, KAN.—A convention of delegates from Central and Western Kansas has been called to meet in this city Aug. 7 to discuss the question of irrigation.

ONTARIO, CAL.—The San Antonio Water Co. has voted to issue bonds for $350,000 to improve its irrigation system.

NEW COMPANIES.—Yellowstone Ditch Co., Rapids, Mont.; $25,000; Chas. Temple, C. R. Watkins, A. E. Parker.——Marble Creek Irrigation Co., Park City, Utah; $20,000; Pres., Abraham Rise; Secy., E. E. Carter; Treas., J. H. Burton.——Shasta Canal & Irrigation Co., San Francisco, Cal.; $100,000; Chas. Rickoff, A. A. Hibbard, Wm. Crain.

SEWERS.

BRUNSWICK, ME.—T. H. Riley, Cy. Clk., informs us that the citizens have voted not to put in a system, but that the question will probably come up again before next spring.

BOSTON, MASS.—The metropolitan sewerage commissioners will receive bids until Aug. 19 for section 44½ of the main sewer, in Winchester; length, 5,700 ft.; average cut to 10 inches below water line of invert, 12 ft.; maximum outside width of masonry, 50 ins.

CHICOPEE, MASS.—We are informed by John D. White, Cy. Clk., that the sewer system of the city is substantially complete. About 2,000 lin. ft. of pipe sewer will be constructed this year.

NORTH BROOKFIELD, MASS.—The town has voted to extend the Gilbert St. sewer 4,400 ft.; estimated cost, $5,000.

FLATBUSH, N. Y.—Samuel H. McElroy has resigned as engineer of the board of sewer commissioners.

JAMAICA, N. Y.—John J. McLaughlin has been engaged to prepare plans for a system.

ROCHESTER, N. Y.—Plans have been prepared for a sewer estimated to cost $36,645.

UTICA, N. Y.—Bids are asked until Aug. 11 for a brick and stone sewer 8 × 6½ to 4½ ft. in diameter; estimated cost, $45,000. The plans are on file at the city clerk's office.

BLOOMFIELD, N. J.—Plans are being prepared for a stormwater sewer from Belleville Ave. and State St. to James St. and Third River; estimated cost, $8,000.

DU BOIS, PA.—Plans have been adopted for a system; total length, 91,740 ft.; estimated cost, $80,268. C. E. L. McQuiston, Butler, Engr.

ALLIANCE, O.—Plans for a system have been approved by the council.

COLUMBUS, O.—The engineer has reported that it will cost $118,054 to complete the sewers not yet under contract in district No. 5.

NORWOOD, O.—Bids are asked until Aug. 19 for sewers in 14 streets. J. M. Harper, Engr., Ninth and Plum Sts., Cincinnati.

INDIANAPOLIS, IND.—The board of public works will receive bids until Aug. 14 for a main and local sewer.

LOWELL, MICH.—Surveys are being made for a system.

PORT HURON, MICH.—Thos. M. Danger, Supt. Pub. Wks., informs us that the council is considering the subject, but that it has not yet taken definite action.

LINCOLN, ILL.—The sewer committee will receive bids until Aug. 20 for a tile sewer in certain streets.

WASHBURN, WIS.—It is reported that a system will be constructed this fall.

MINNEAPOLIS, MINN.—The committee has decided upon the construction of several sewers.

KIRKWOOD, MO.—Geo. D. Dana and G. C. Burr have been appointed a committee to investigate the question.

ST. LOUIS, MO.—The board of public improvements will receive bids until Aug. 22 for sewers in seven districts.

DENVER, COLO.—Contracts have been awarded to J. B. Hindry as follows: South side sewer, $97,843; North Denver, No. 2, $85,000; Capitol Hill, $94,737. The engineer's estimates were $118,680, $101,472, and $117,260, respectively.——Additional work has been ordered; estimated cost, $16,524.

STREETS.

BROOKLYN, N. Y.—Bids are asked until Aug. 9 for paving two streets with cobblestones. John P. Adams, Comr. Cy. Wks.

NEW YORK, N. Y.—The commissioners of public works has decided to pave 12 streets with asphalt; estimated cost, about $300,000.

NORTH TONAWANDA, N. Y.—T. W. Barrally, Engr., has reported that it will cost $48,000 to pave Oliver St., 38 ft. wide between curbs with 14 ft. on either side for sidewalks. A concrete foundation 6 ins. deep will be used.

SYRACUSE, N. Y.—The contract for paving Mulberry St. with Trinidad Lake asphalt has been awarded to the Warren-Scharf Asphalt Paving Co., at $167,215. Bids for paving Midland Ave. have been received as follows: From West Onondaga St. to Brighton Ave. with brick,—John M. Mack & Co., $82,816; W. G. Sprague, $83,596; from West Onondaga St. to Colvin St. with Trinidad asphalt,—Syracuse Improvement Co., $72,444; Trinidad Asphalt Refining Co., $77,441; Warren-Scharf Asphalt Paving Co., $74,371.

YONKERS, N. Y.—The contract for the Warburton Ave. extension improvement has been awarded to Pennell & O'Hern, at $89,443, other bids being Dougherty & Berryan, $89,661, and Brendlinger, $95,500.

NANTICOKE, PA.—The "News" is urging that Main St. be paved, the estimated cost being $1.80 to $2.07 per sq. yd. for brick upon six inches of gravel, or $2.25 upon three inches of concrete; Belgian blocks, $2; asphalt blocks, $2.60.

WILLIAMSPORT, PA.—The council has voted to pave West Third St. with asphalt.

WASHINGTON, D. C.—The Northeast Washington Citizens' Assn. has voted to petition the district commissioners to improve 19 streets.

NEW ORLEANS, LA.—Bids are asked until Aug. 7 for paving several streets with granite blocks. Chas. R. Kennedy, Cy. Comp.

COVINGTON, KY.—Bids are asked until Aug. 8 for 12,140 sq. yds. brick paving. T. H. Kennedy, Cy. Engr.

BELLAIRE, O.—John R. Gow, Cy. Clk., informs us that bids will be received until Aug. 22 for paving eight streets with brick.

BELLEVUE, O.—John Laylin, Engr., informs us that a contract for paving 6,700 sq. yds. with East Clayton brick on a crushed limestone foundation has been awarded to Louis Mayer, Lancaster, at $10,200.

CINCINNATI, O.—The board of administration will receive bids until Aug. 23 for paving one street each with brick and cobblestones, in addition to the work noted last week.

DELAWARE, O.—All bids for improving South Union St. have been rejected, and the specifications will be changed.

HAMILTON, O.—Bids are asked until Aug. 15 for grading, graveling and paving with brick and cement; four contracts. J. J. McMaker, Cy. Clk.

LUDLOW GROVE, O.—Bids are asked until Aug. 17 for grading, macadamizing, constructing cement sidewalks, etc., in the village of St. Bernard. John G. Overman, Vil. Clk.

NORWOOD, O.—Bids are asked until Aug. 25 for about $23,000 of street improvement bonds. W. E. Wichgar, Vil. Clk.

ELKHART, IND.—Bids are asked until Aug. 23 for cement sidewalks. Geo. H. Fisher, Cy. Clk.

DETROIT, MICH.—Three contracts for paving with brick on concrete have been awarded to H. S. Hallwood, at about $74,000.

PORT HURON, MICH.—The council is considering paving with both brick and wooden blocks, but has taken no definite action. Thos. M. Danger, Supt. Pub. Wks.

URBANA, ILL.—Bids are asked until Aug. 12 for about a mile of brick paving, C. B. Holmes, Cy. Clk.

MINNEAPOLIS, MINN.—The city engineer has been instructed to have three streets paved with cedar blocks.

DENVER, COLO.—Plans have been prepared for paving estimated to cost about $43,000.

SALEM, ORE.—W. J. Culver, Cy. Engr., is preparing plans for the improvement of State St.; estimated cost, $10,000.

ELECTRIC LIGHT AND POWER.

DANIELSONVILLE, CONN.—F. T. Preston, Tn. Clk., informs us that a contract is being made with the Killingly Electric Light & Power Co. to be submitted to a vote of the borough Aug. 4.

TRENTON FALLS, N. Y.—It is proposed to utilize the water power, about 6,000 HP., at this place to generate electricity to be transmitted to Utica for light and power purposes. E. D. Mathews is interested.

BLADENSBURG, MD.—Steps are being taken to secure a municipal electric light plant.

QUITMAN, GA.—The city council is reported as securing estimates for water-works and electric lights.

LINWOOD, O.—Bids are asked until Aug. 22 for a plant, as stated in our advertising columns. Geo. Hornung, Consult. Engr.

MANCELONA, MICH.—The council will award a franchise to desirable parties; population, 1,500. O. R. Rodenbaugh, Vil. Pres.

TRENTON, ILL.—The council desires proposals for a plant of at least 23 arc lights, or will award a free franchise, according to reports.

GAINESVILLE, TEX.—Bids are asked for electric lighting. R. S. Rollens, Mayor.

PAYALLUP, WASH.—An electric power plant is included in the plans of the proposed water-works. Wm. M. Seeman, Cy. Clk.

NEW COMPANIES.—Cascade Power Co., Westfield, Mass.; $100,000; Pres., J. A. Lakin; Treas., L. C. Atwater.——Spencer Electric Light & Power Co., Belding, Mich; water power has been purchased at Smyrna and electricity will be furnished for lighting and for a new street railway; Pres., Fred. L. Spencer; Treas., W. P. Hetherington.——Montclair Light & Power Co., Denver, Colo.; $50,000; E. W. Rollins, W. G. Fisher, G. A. Batchelder.

CONTRACT PRICES.

CULVERT.—Oxford, O.—The county commissioners have contracted with Wm. A. Hester to build an arch culvert 30 ft. long, 13 ft. high and 10 ft. wide, at $3.90 per perch.

RIVER WALL.—Holyoke, Mass.—The following bids have been received for a river wall: G. L. Bosworth & Co., rubblestone masonry, $6.25 per cu. yd., and flagging, 22 cts. per sq. ft.; Timothy Mahoney, $4.75 and 18 cts.; Frank Rivers, $5.50 and 17 cts.

BRICK PAVING.—Quincy, Ill.—The lowest bids for paving two streets with brick were those of T. J. Shea, at $1.38 and $1.40 per sq. yd. for paving, 53 cts. per lin. ft. for new curbing, and 10 cts. for resetting old curbing.

BRICK AND CEDAR BLOCK PAVING.—Detroit, Mich.—The board of public works has recommended that contracts be awarded as follows: Brick on concrete, —H. S. Hallwood, $2.18¾ and $2.21 per sq. yd.; Archie Grant, $2.21; cedar blocks on plank—Thos. Currie, $1.75; Lennane Bros., $1.73; Henry Merdian, $1.81; Geo. E. Currie, $1.77½; Patrick Dee, $1.71; Laidlaw Bros., $1.18½; T. J. Kennedy, $1.76½. Bids of $1.86½ for cedar on plank and $2.16¾ and $2.21½ for cedar on concrete were rejected as being too high.

ASPHALT PAVING.—Utica, N. Y.—The council has awarded the contracts for paving Plant and Jewett Sts. with Trinidad Lake asphalt to John H. Patterson, representing the Trinidad Asphalt Paving Co., and Michael T. Bannigan, representing the Warren-Scharf Asphalt Paving Co., respectively, at $1.95 per sq. yd. These bids were 15% lower than those of the Utica Paving Co., which had previously been accepted for this work, according to reports. The contract for Rutgers St. was awarded to the Utica Paving Co., the itemized bids having been published in our issue of July 20.

DAM.—Boston, Mass.—Bids were opened July 17 for dam No. 5 for the Sudbury River supply of the city water-works. The dam will be located in the town of Southborough, will be about 1,950 ft. in length on top, have a masonry overfall 321 ft. in length and 75 ft. above the bed of the brook, and the reservoir is expected to have a capacity of 7,500,000,000 gallons. Wm. Jackson, Cy. Engr., informs us that the contract has been awarded to Moulton & O'Mahoney, Boston and Lawrence, at the following prices: Soil excavated and put in spoil banks, 14,000 cu. yds., at 24 cts.; excavated and placed on dam, 13,900 cu. yds., 28 cts.; sodding, 1,610 sq. yds., 25 cts.; seeding, 5 acres, $40; earth excavation, 230,000 cu. yds., 34 cts.; rehandling, 10,000 cu. yds., 10 cts.; rock excavation, 13,400 cu. yds., $1.67; timber work, 2,000 ft. B. M., $35; timber work, tongued and grooved, 2,000 ft. B. M., $60; Portland cement, 100 bbls., $3; concrete masonry, 14,000 cu. yds., $4.70, and 800 cu. yds., $6; plastering, 9,270 sq. yds., 67 cts.; brick masonry, 256 cu. yds., $19; paving, 7,500 cu. yds., $4; riprap, 10,100 cu. yds., $1.50; broken stone, 5,400 cu. yds., $2.25; rubblestone masonry, 22,200 cu. yds., $5.50; facing stone masonry, 13,300 sq. ft. broken ashlar, 75 cts., and 3,650 cu. yds. range work, $17; coping, 320 lin. ft., $5; dimension stone masonry, 290 cu. yds., $40; hammered work, 4,110 sq. ft., 75 cts.; masonry, 1,000 cu. yds. each, in American cement, 1 to 1, $1.25; Portland cement, 1 to 1, $3.50; 1 to 2, $2.50; 1 to 3, $1.75; walks, 1,575 lin. ft., $1; total bid with paved slopes, $454,730; with riprapped slopes, $446,830.

SEWERS.—Dayton, O.—We have received from Stanley & Pierson, engrs., a statement of the bids received for sewers in districts Nos. 2, 3, 4 and 5 and in No. 8, the bids published July 20 having been taken from a newspaper item. The total bids were as follows: District No. 8.—Jno. Munger & Co., Dayton, $46,102; J. C. Marry, Newark, $48,305; Standard Const. Co., Columbus, $40,103; Clements Bros. Const. Co., Cleveland, $39,60[illegible]; Ed. Ryan, Springfield, $47,556; Bruno Ritty, Dayton, $46,229; B. D. Barton, Port Huron, Mich., $32,615; W. A. Cain, Dayton, $51,138. Nos. 2, 3, 4 and 5.—Jno. Munger & Co., $85,894; Bruno Ritty, $102,098; B. D. Barton, $74,760; W. A. Cain and J. E. Lowes, $97,068; E. Ryan, $115,794; Oliver G. Kringle, Dubuque, Ia., $95,029; Clements Bros. Const. Co., $100,347; Standard Const. Co., $87,756. The prices for the work in districts Nos. 2, 3 4 and 5 ranged as follows: Furnishing and laying sewer pipe, including Y's, spiral pieces and joints, 18-in., 52 to 80 cts. per lin. ft.; 15-in., 33 to 60 cts.; 12-in. 26 to 45 cts.; 10-in., 19¼ to 35 cts.; 8-in., 15 to 25 cts.; 6-in., 11 to 30 cts.; 5-in., 7¼ to 20 cts.; excavating and back filling, less than 6 ft. deep, 20 to 35 cts. per lin. ft.; 6 to 8 ft., 22 to 50 cts.; 8 to 10 ft., 29 to 90 cts.; 10 to 12 ft., 40 cts. to $1.50; 12 to 14 ft., 43 cts. to $2.25; 14 to 16 ft., 45 cts. to $3; 16 to 18 ft., 50 cts. to $4.86; 18 to 20 ft., 75 cts. to $5.60; repaving, 11 to 60 cts. per lin. ft.; manholes complete, $20 to $40 each; lampholes complete, $3 to $10; flush tanks, $30 to $50 (one bid of $4.50); iron pipe, $32 to $65 per ton; brick sewer, 40-in., $2.32 to $3.85 per lin. ft.; 36-in., $1.90 to $3.65; 30-in., $1.60 to $3.35; 24-in., 70 cts to $2.75; tile drains laid, 8-in., 7 to 27 cts. per lin. ft.; 6-in., 5 to 24 cts.; 4-in., 4 to 20 cts.; flush tank connections, lead pipe without trenching, 14 to 75 cts. per lin. ft.; lead pipe with trenching, 30 to 95 cts.; corporation cock and specials, $2 to $10 each connection; embankment, 25 to 65 cts. per cu. yd.; brick masonry, $12 to $16 per M; rubble stone masonry, $3.50 to $6.50 per cu. yd.; concrete, $2.75 to $4.75 per cu. yd.; excavation, 30 to 80 cts. per su. yd.; sheeting lumber left in work, $12 to $20 per M ft.

MISCELLANEOUS.

CULVERT.—Rockland, Me.—The street commissioners will receive bids until Aug. 12 for a granite culvert.

PLATTING.—New Bedford, Mass.—Bids are asked until Sept. 1 for platting the territory of the city, as stated in our advertising columns.

BONDS.—Victoria, B. C.—Bids are asked until Aug. 22 for $95,788 of city bonds, including $10,788 of improvement bonds. Wellington J. Dowler, Cy. Clk.

PARK IMPROVEMENTS.—New York, N. Y.—The contract for improving the military parade ground in Van Cortlandt Park has been awarded to John Cox, at $93,138.

GARBAGE CREMATOR.—Chicago, Ill.—The mayor and chairman of the council finance committee have been authorized to negotiate for a 100,000-ton garbage cremator.

LOCK GATES, PUMPS, ETC.—Detroit, Mich.—Bids will be received at the U. S. Engineer Office until Sept. 19 for the gates for the 800-ft. lock, St. Mary's Falls Canal; and until Sept. 27 for centrifugal pumps, driving machinery, and Babcock & Wilcox boilers for the pumping plant for St. Mary's Falls Canal. Col. O. M. Poe, U. S. A.

IRON WORK, ETC.—San Bernardino, Cal.—The trustees of the State Asylum for the Insane and Inebriates will receive bids until Aug. 21 for the following work for a ward building; Masonry and iron work; carpenter and plasterers' work; plumbing, gasfitting and steam heating; galvanized iron and tin work; painting and polishing; electrical work. H. L. Drew, Chn.

REMOVING EARTH, ETC.—New York, N. Y.—Bids will be received at the U. S. Engineer Office until Aug. 24 for removing 260,000 cu. yds. mud, earth, rock, etc., from the Harlem River, Spuyten Duyvil Creek, and from the dams inclosing the cut through Dyckman Meadow, and for constructing revetments for slopes of the sections excavated. Lieut.-Col. G. L. Gillespie, U. S A.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Richmond Locomotive Works, Richmond, Va., have a contract for 30 ten-wheel freight engines for the Cleveland, Cincinnati, Chicago & St. Louis Ry., at $9,740 each.

The Rogers Locomotive Co., Paterson, N. J., is building 5 eight-wheel passenger engines and 7 ten-wheel freight engines for the Florida Central & Peninsular. The company's exhibit at the World's Columbian Exposition is described in another column.

CARS.—The Wason Mfg. Co., Springfield, Mass., has built 30 passenger cars for the Delaware & Hudson, and is building 75 cars for the Manhattan elevated road, New York.

The Pullman Palace Car Co., Chicago, Ill., is building 10 passenger cars and 10 smoking cars for the Maine Central. It has delivered 40 sleeping cars and 10 parlor cars to the Pennsylvania.

The Terre Haute Car & Mfg. Co., Terre Haute, Ind., has orders for 150 freight cars for the Calumet & Blue Island, and 50 poultry cars for the Live Poultry Transportation Co., of Chicago.

THE STILWELL-BIERCE & SMITH-VAILE CO., Dayton, O., has an interesting exhibit at the World's Columbian Exposition. It embraces Victor turbines of both "register gate" and "cylinder gate" patterns, arranged on both vertical and horizontal shafts. These turbines are built in a great variety of styles and sizes. Another feature of the exhibit is the Stilwell "open" and "close" heaters and the live steam purifier for heating and purifying feed-water for steam boilers. The practical efficiency of these heaters is demonstrated by a display of lime deposits taken from heaters in operation in various sections of country. The exhibit also contains a display of "Smith-Vaile" steam pumps in great variety of styles and for every duty.

THE LAIDLAW & DUNN CO., of Cincinnati, and the Gordon Steam Pump Co., of Hamilton, O., have consolidated, and are now under the same management. Expert hydraulic engineers have been employed, whose specialty has been in connection with pumping machinery of various types, and the correspondence with superintendents of water-works for the past three years has been carefully examined with a view to making improvements in the patterns of the pumping machines made by these companies. It is stated that several such changes have already been made. The Laidlaw, Dunn, Gordon Co., as the new company is known, has also purchased land for the erection of more extensive works for the manufacture of steam pumps.

HENRY R. WORTHINTON, New York, will furnish the new pumping engines for the water supply of the city of Osaka, Japan. By placing this order there is literally a "girdle round the earth" of Worthington pumping engines, these machines having worked their way as far east as China up to the time of the awarding of this last contract.——The new American Line steamers now building at Cramp's Yard, Philadelphia, will be fitted throughout with Worthington pumps. The order for the pumps also covers Worthington feed-water heaters, such as are now used on some of the fastest transatlantic liners, among which are the "New York" and "Paris" of the American Line.

THE KING BRIDGE CO., of Cleveland, O., is rebuilding its riveting shop, which was recently destroyed by fire, and expects to have the new building completed shortly. It will be of brick, 200 × 320 ft. in the clear, and will be as nearly fireproof as possible. The company contemplates adding new and improved machinery and will be busily engaged for some time on contracts now in hand, among which are four spans of about 200 ft. each for the city of Des Moines, Ia.; one clear span of 435 ft. for Frankfort, Ky.; a heavy 250-ft. draw span with two 100-ft. approach spans over the Harlem ship canal for New York City; also 360-ft. draw, with 250-ft. fixed span, for the Jacksonville & Southeastern line over the Illinois River at Havana, Ill.; 1,600-ft. viaduct near Cleveland; the 400-ft. four-track drawbridge for the New York Central R. R. over the Harlem River in New York (Eng. News, June 15), together with numerous other bridges for different railways.

NEW COMPANIES.—Nordlund Arc Lamp Co., Seattle, Wash.; $15,000; L. B. N. Nordlund, Robert J. Wilson and C. A. White. Smith Locomotive Fire Kindling Co., Chicago, Ill.; $100,000; Charles T. Smith and C. G. Fairchild. Brown Car Coupler Co., Washington, D. C.; $100,000; A. H. Sommer, A. H. Scott and P C. Brownall. Springfield & Sedalia Construction Co., St. Louis, Mo.; $50,000; J. S. Robbins, M. J. Shelley and R. Dunsford.

NOTICE TO CONTRACTORS.

SEALED BIDS for the doing of the work and the furnishing of the materials necessary for the paving of Oliver street, in the Village of North Tonawanda, N. Y., from the north line of Tremont street to the south line of Wheatfield street, with vitrified paving brick, in accordance with the plans and specifications for the paving of said street, adopted by the Board of Trustees of the said village of North Tonawanda, N. Y., at a meeting of said Board of Trustees, held Tuesday, July 25, 1893, will be received by said Board of Trustees at a meeting to be held at the Council Chamber in said village, on the 22d day of August, 1893, at 8 o'clock p. m.

All bids must be accompanied by a New York draft or certified check for ten per cent. of the amount of the estimate, payable to the order of Geo. W. Stanley, President of the said Village of North Tonawanda, N. Y., as a guarantee that the bidder, if successful, will enter into a contract for the performance of the work.

All bids must be made upon the blank forms furnished by the Board, and be sealed in an envelope marked "Proposal for Street Paving," and indorsed with the name of the bidder.

Bidders will be required to submit, with their proposal for the work, samples of bricks. Each sample must be labeled plainly in ink with the kind of brick, name and address of the person submitting the proposal.

Plans, profile and specifications may be seen at the office of the Village Clerk, Herald Building, near corner of Main and Goundry streets, North Tonawanda, N. Y., after Monday. August 9, 1893.

Specification and proposal blanks will be furnished on application.

The Board reserves the right to reject any and all bids.

North Tonawanda, N. Y., July 28, 1893.
By order Board of Trustees.
31-3t T. E. WARNER, Village Clerk.

PUMPING ENGINE.

Plans and proposals are invited until 10 a. m. August 31, for furnishing to the City of Providence an apparatus for raising water from Pawtuxet River, at Pettaconset, into Sockanosset reservoir, under the following conditions: To deliver fifteen million gallons per day on one hundred and eighty feet lift while performing a duty of at least one hundred millions, based on the coal supplied; to be placed, without serious changes of the present construction, in the east wing of the main engine house, so as to take water from the pump well and deliver it into the stand-pipe; to have ample boilers of the best quality capable of generating ten pounds of steam for each pound of coal burned; to have complete connections and equipment ready to run permanently.

In comparing bids a proper allowance will be made for each million of duty guaranteed above that herein stipulated.

Further information will be given by the City Engineer.

The right to reject any or all bids is reserved. ROBERT E. SMITH,
Commissioner of Public Works.
City Hall, Providence, R. I., July 27, 1893. 31-4t

U. S. ENGINEER OFFICE, Army Building, New York, July 24, 1893.—Sealed proposals for removing 260,000 cubic yards, more or less, of material, mud, earth, ledge rock, broken stone, old timber, etc., from the Harlem River, Spuyten Duyvil Creek, and from the dams inclosing the cut through Dyckman Meadow, on the line of the Harlem River improvement, and for furnishing the materials and workmanship for the construction of revetments for slopes of the sections excavated, will be received at this office until 12 o'clock noon, Aug. 24, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. G. L. GILLESPIE, Lieut.-Colonel, Corps of Engineers. 31-4t

U. S. ENGINEER OFFICE, 34 West Congress St., Detroit, Mich., July 29, 1893.—Sealed proposals for (A) centrifugal pumps; (B) the driving machinery; and (C) the Babcock & Wilcox boilers for pumping plant for St. Mary's Falls Canal, will be received at this office until 2 p. m. September 27, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. O. M. POE, Col. Corps of Engineers, etc. 31-4t